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ABSTRACT

This document is a teacher's guide for teaching a course on robot service and repair. The guide is organized in four units covering the following topics: introduction to robots, power supply, robot control systems, and service and repair. Each unit contains several lesson plans on the unit topic. Lesson plans consist of objectives, tools and materials needed, teaching aids. information sheets, assignment sheets, references, a complete presentation outline, classroom or laboratory activities, review items, unit test items with answers, and transparency masters. (KC)

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ROBOT SERVICE AND REPAIR

TEACHER'S GUIDE

Kansas Vocational Curriculum Dissemination Center
Department of Vocational Technical Education
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Pittsburg State University
Pittsburg, KS 66762

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Lesson Plan # 1

Course Title ROBOT SERVICE AND REPAIR Course # _____

Unit Title INTRODUCTION TO ROBOT Unit # 1

Technical Information Lesson X General /Guidance Information Lesson ___

OR

Job Skill Demonstration Lesson _____

ROBOT HISTORY AND ITS TREND

LESSON TITLE

Lesson Objective - Upon Completion of This Lesson the Student Should Be Able To:

1. TELL WHERE THE WORD "ROBOT" COMES FROM.
2. EXPLAIN THE DIFFERENCE BETWEEN HARD AUTOMATION DEVICES AND ROBOTICS.
3. LIST THE REASONS WHY INITIALLY U.S. INDUSTRY HAS NOT SHOWN AN INTEREST IN EMPLOYMENT OF ROBOTS IN APPLICATIONS OTHER THAN HOT, HEAVY, AND HAZARDOUS ENVIRONMENT.

Tools and Materials:

Teaching Aids:

H1-1-1 SYLLABUS SHEET
T1-1-1 A HISTORY OF ROBOTS
T1-1-2 A HISTORY OF UNIMATION
T1-1-3 STATISTICS
T1-1-4 U.S.-JAPAN COMPARISON ON INDUSTRIAL ROBOTS
T1-1-5 WHY JAPAN IS SUCCESSFUL IN ROBOTIZATION

Informational Assignment:

INFORMATION SHEETS
IS1-1-1 ROBOT HISTORY
IS1-1-2 EVOLUTION OF INDUSTRIAL ROBOTS
IS1-1-3 DOMESTIC vs FOREIGN DEVELOPMENT OF INDUSTRIAL ROBOTS
IS1-1-4 FUTURE OF ROBOTS

ANSWER QUESTIONS FOUND ON ASSIGNMENT SHEETS
AS1-1-1 ROBOT HISTORY AND ITS TREND

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Individualized Informational Assignment for Special Students:

References:

1. ENGELBERGER, J.F. ROBOTICS IN PRACTICE, AMERICAN MANAGEMENT ASSOCIATION, NEW YORK, 1980, PP. 1-7
2. HSIC, A. INDUCTION TO ROBOTICS AND ITS TREND, SUNY COLLEGE OF TECHNOLOGY, NEW YORK, 1983.

Step 1 - Introduction for Preparation of the Student:

ALTHOUGH THE "ROBOT" IDEA HAS BEEN IN OUR SOCIETY FOR SEVERAL DECADES, THE USE OF THE INDUSTRIAL ROBOT IN THE INDUSTRIAL ENVIRONMENT HAS NOT BEEN LONG.

DURING THE 1960-1970's PERIOD, MOST ROBOTS WERE USED RESTRICTEDLY IN HOT, HEAVY, AND HAZARDOUS AREAS. HOWEVER, AFTER 1976, JAPAN'S SUCCESS IN ROBOTICS APPLICATION AND PRODUCTION HAS CHANGED ALL CONCEPTS. THE REST OF THE WORLD HAS OVERWHELMINGLY ACCEPTED THE EMERGENCE OF THE ROBOT, AS A MODEL OF ANOTHER INDUSTRIAL REVOLUTION.

IN THIS UNIT, THE STUDENT WILL KNOW WHERE THE WORD "ROBOT" COMES FROM, WHEN IT IS USED IN REAL INDUSTRIAL OPERATIONS, HOW THE INDUSTRIAL ROBOT EVOLVED, AND THE ROBOTICS APPLICATION AND DEVELOPMENT FOR THE FUTURE.

Lesson Plan # 1

Course Title ROBOT SERVICE AND REPAIR Course # _____

Unit Title INTRODUCTION TO ROBOT Unit # 1

Lesson Title: ROBOT HISTORY AND ITS TREND

STEP 2 - Presentation Outline:

I. ROBOT HISTORY
   - A. THE POINT IN TIME THAT MARKS THE BEGINNING OF ROBOT TECHNOLOGY VARIES FROM AUTHOR TO AUTHOR.
   - B. MOST AUTHORS, HOWEVER, HAVE CHOSEN THE YEAR 1923 AS A SERIOUS STARTING POINT OF ROBOT HISTORY.
   - C. IN 1923, ROBOTS ENTERED THE ENGLISH VOCABULARY WITH TRANSLATION OF KAREL CAPEK'S PLAY R.U.R.(ROSSUM'S UNIVERSAL ROBOTS).
   - D. MID 1950'S THERE WERE SEVERAL ATTEMPTS MADE TO BUILD A ROBOT WITH INDUSTRIAL APPLICATIONS.
   - E. IN 1961, GENERAL MOTORS INTRODUCED ROBOTS INTO ITS AUTO PRODUCTION LINES.
   - F. DURING THE 1960 AND 1970'S, THE ROBOTS USES WERE PRIMARILY RESTRICTED TO APPLICATIONS THAT WERE HOT, HEAVY, AND HAZARDOUS.
   - G. AFTER 1970, ROBOTICS APPLICATIONS IN INDUSTRIES WERE INCREASED VERY MUCH.

II. EVOLUTION OF INDUSTRIAL ROBOTS
   - A. THE PRINCIPLE TECHNOLOGICAL CONTEXT OF ROBOTICS IS THE FIELD OF INDUSTRIAL AUTOMATION.
   - B. ROBOTS CAN BE DESCRIBED AS AN EQUIPMENT THAT WE USE IN HARD AUTOMATION.
   - C. ROBOT APPLICATIONS BECAME FEASIBLE THROUGH THE ADVERT OF DIGITAL LOGIC AND MINIATURED SOLID STATE ELECTRONICS-THE VERY SAME TECHNIQUES USED IN COMPUTERS AND IN NUMERICALLY CONTROLLED MACHINE TOOLS.
   - D. ROBOTS WERE ACCEPTED BY INDUSTRIES AS MODEL OF ANOTHER INDUSTRIAL REVOLUTION.

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III. DOMESTIC vs FOREIGN DEVELOPMENT OF INDUSTRIAL ROBOTS

A. MOST IMPORTANT WORKS ON ROBOT TECHNOLOGY THAT WERE CONDUCTED IN THE U.S. WERE DURING THE EARLY SIXTIES.

B. THE REASONS WHY THE U.S. INDUSTRY IS RELUCTANT TO EMPLOY ROBOTS IN OTHER THAN APPLICATIONS THAT WERE HOT, HEAVY, AND HAZARDOUS ARE:

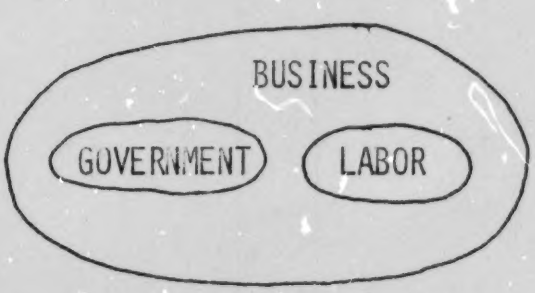
1. HIGH INITIAL COST AND EXTENDED PAYBACK PERIODS
2. LABOR'S NEGATIVE REACTION TO ROBOTS
3. GOVERNMENT'S FAILURE TO RECOGNIZE ROBOTS AS A MEANS OF INCREASING THE COUNTRY'S PRODUCTIVITY
4. SHORT-SIGHTED MANAGERS IN MOST U.S. FACTORIES

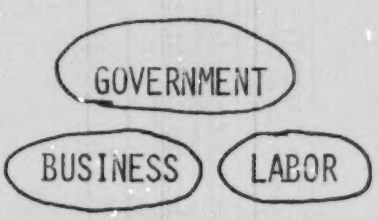
C. JAPAN, WEST GERMANY AND THE OTHER INDUSTRIALIZED COUNTRIES RECOGNIZED THE PRODUCTIVITY AND PRODUCT QUALITY GAINS TO BE MADE FROM THE APPLICATION OF ROBOT TECHNOLOGY AND APPLIED IT EXTENSIVELY.

D. JAPAN HAS BECOME A LEADER IN THE APPLICATION OF ROBOT TECHNOLOGY WITH NEARLY HALF OF THE WORLD'S ROBOTS WORKING IN JAPANESE INDUSTRIES.

E. JAPAN'S LEADERSHIP IN THE APPLICATION OF ROBOT TECHNOLOGY DID NOT COME ABOUT BY CHANCE, BUT WAS CULTIVATED BY A STRONG COMMITMENT FROM GOVERNMENT AND INDUSTRIAL AND NURTURED BY SOME UNIQUE SOCIAL ASPECTS OF JAPANESE CULTURE.

F. JAPANESE SOCIETY STRUCTURE vs U.S.





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VI. FUTURE OF ROBOTS

1. THE FUTURE IS BRIGHT FOR INDUSTRIAL ROBOTS WORLDWIDE. JAPAN, WEST GERMANY, AND FRANCE, AS WELL AS THE U.S., ARE MOVING STRONGLY AHEAD NOT ONLY IN APPLICATIONS BUT ALSO IN THE PRODUCTION OF ROBOTS.
2. IN THE U.S., ROBOTS ARE SEEN AS THE KEY TO INCREASED PRODUCTIVITY WHICH IS NEEDED TO MAKE INDUSTRY WHOLE AGAIN.
3. ROBOTS ARE BEING VIEWED AS THE NEW SAVIOR OF THE FALTERING U.S. ECONOMY BY BOTH GOVERNMENT AND INDUSTRY.
4. THE MANUFACTURING OF ROBOTS WILL BE ONE OF THE HIGH TECHNOLOGY GROWTH INDUSTRIES IN THE FUTURE.
5. THE ROBOTIZATION OF U.S. INDUSTRY MEANS MORE THAN JUST THE INCREASE IN PRODUCTIVITY AND ITS POSITIVE ECONOMIC EFFECTS, THERE ARE ALSO THE SOCIAL CONSEQUENCE TO CONSIDER.
6. BIG ISSUE-IF ROBOTS EVENTUALLY DO MOST OF THE ECONOMICALLY PRODUCTION WORK, HOW WILL PEOPLE PERCEIVE AN INCOME? WHO WILL OWN THESE MACHINES AND WHO WILL CONTROL THE POWERFUL AND ECONOMIC AND POLITICAL FOCUS THEY REPRESENT?

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Lesson Plan # 1

Course Title ROBOT SERVICE AND REPAIR Course # _____

Unit Title INTRODUCTION TO ROBOT Unit # 1

STEP 3 - Classroom, Laboratory, Shop or Other Activities:

STEP 4 - Lesson Summary and Review Items to be Used to Evaluate the Lesson Against the Lesson Objective:

INTERACTION ITEMS:

1. WHERE DOES THE WORD "ROBOT" COME FROM?

   The word "robot" comes from Karel Capek's play R.U.R. in 1923.

2. WHAT DOES HARD AUTOMATION MEAN?

   Hard automation can be described as an equipment designed to accomplish repetitive production line tasks at a fast pace.

3. WHY IS THE U.S. INDUSTRY RELUCTANT TO USE ROBOTS IN ITS PRODUCTION LINE?

   1. High initial cost and extended payback periods.
   2. Labor's negative reaction to robots.
   3. Government's failure to recognize robots as a means of increasing the nation's productivity.
   4. Short-sighted managers in most U.S. factories.

4. STATE THE FUTURE OF THE INDUSTRIAL ROBOTS.

   The future of industrial robots is bright worldwide. Some industrialized nations are moving strongly ahead in applications and production of robots.

Lesson Plan # 1

Course Title/No. ROBOT SERVICE AND REPAIR Course # _____

Unit Title INTRODUCTION TO ROBOT Unit # 1

Unit Test Items **Oral, Written, or Performance:**

TRUE-FALSE

T 1. KAREL CAPEK WAS A CZECH, AND IN HIS NATIVE LANGUAGE THE WORD "ROBOT" SIMPLY MEANT A WORKER.

T 2. JOSEPH F. ENGELBERGER WAS THE FIRST MAN RESPONSIBLE FOR DEVELOPING THE ROBOTS THAT WERE TO BE USED IN PRODUCTION OPERATION.

F 3. IN 1961, JAPANESE AUTO CAME TO UNIMATION TO BUY ROBOTS. FIVE YEARS LATER, THEY WERE SUCCESSFUL IN ROBOT APPLICATIONS.

T 4. THE FUNCTION OF HARD AUTOMATION IS USUALLY VERY SPECIFIC, AND THERE IS SELDOM A NEED TO ALTER ITS OPERATION.

F 5. JAPANESE SUCCESSFUL STORIES IN ROBOTICS APPLICATIONS WERE NOT ACCEPTED BY THE REST OF THE WORLD.

T 6. THE INDUSTRIALIZED COUNTRIES RECOGNIZED THE PRODUCTIVITY AND PRODUCT QUALITY GAINS TO BE MADE FROM THE APPLICATION OF ROBOT TECHNOLOGY.

COMPLETION

1. IN 1961, GENERAL MOTORS INTRODUCED ROBOTS INTO ITS AUTO PRODUCTION OPERATION.
2. ENGELBERGER DID MORE THAN ANYONE ELSE TO BRING ROBOTS INTO INDUSTRY. HE IS NOW WIDELY RECOGNIZED AS THE FATHER OF ROBOTS.
3. DURING THE 1960 AND 1970'S, THE ROBOTICS APPLICATION WAS PRIMARILY RESTRICTED TO THE HOT, HEAVY, AND HAZARDOUS AREAS.
4. THE PRINCIPLE TECHNOLOGICAL CONTEXT OF ROBOTICS IS THE FIELD OF INDUSTRIAL AUTOMATION.
5. THE ROBOT THAT HAD AN ADDITION OF SERVO CONTROLS ARE THE VERY SAME TECHNIQUES USED IN COMPUTERS AND NUMERICALLY CONTROLLED MACHINE TOOLS.
6. IN THE U.S., ROBOTS ARE SEEN AS THE KEY TO INCREASE INDUSTRIAL PRODUCTIVITY.

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A HISTORY OF ROBOT

1923	THE WORD ROBOT WAS INTRODUCED
1950's	GEORGE DEVOL AND JOSEPH ENGELBERGER
1961	UNIMATION FORMED
1971	JAPANESE AUTO COMPANY BOUGHT ROBOTS FROM U.S.
1976	JAPANESE SUCCESSFUL STORIES WERE ACCEPTED BY THE REST OF THE WORLD
1982	U.S. HAS ABOUT 6,500 ROBOTS--JAPAN HAS ABOUT 25,000 ROBOTS

A HISTORY OF UNIMATION

-- 1952 - GEORGE DEVOL TAKES OUT BASIC PATENTS.
-- 1961 - UNIVERSAL AUTOMATION FORMED BY JOSEPH ENGELBERGER
-- 1962 - FIRST ROBOT SOLD (1900A).
-- 1968 - 2000A INTRODUCED.
-- 1972 - 4000A AND 2000B INTRODUCED.
-- 1974 - 4000B INTRODUCED.
-- 1975 - 2000F (CONTINUOUS PATH) INTRODUCED.
-- 1976 - 2000G (HEAVY DUTY) INTRODUCED.
-- 1979 - PUMA SERIES INTRODUCED.
-- 1980 - APPRENTICE INTRODUCED.
-- 1981 - SERIES 9000 INTRODUCED.

STATISTICS (1981)

	UNITS
JAPAN	25,000
U.S.A.	6,500
EUROPE	3,500
OTHER	6,000
	41,000

U.S.-JAPAN COMPARISON (1980) ON INDUSTRIAL ROBOT

	U.S.	JAPAN
PRODUCTION IN UNITS	1,269	3,200
PRODUCTION IN VALUE ($ MILLIONS)	180	180
INSTALLED OPERATING UNITS	4,370	11,250

WHY JAPANESE ARE SUCCESSFUL IN ROBOTIZATION:

A. LABOR PRACTICES:

LIFETIME EMPLOYMENT

BONUSES BASED ON COMPANY PROFITABILITY

QC CIRCLES

REFRAINING PROGRAMS

B. MANAGEMENT:

MANAGERS ARE GENERALISTS

MANAGERS HAVE LONG-RANGE OUTLOOK

WILLING TO ACCEPT HIGH INITIAL COST AND LONGER PAYOFF TIME.

C. GOVERNMENT EFFORTS:

ADDITIONAL DEPRECIATION ALLOWANCE FOR ROBOTS INSTALLATION

LOW INTEREST LOANS FOR THE PURCHASE OF ROBOTS

SUPPORT THE FOUNDING OF JAPAN ROBOT LEASE COMPANY

HUGE MONEY INVESTED IN RESEARCH AND DEVELOPMENT FOR ROBOTICS

D. JAPANESE NATIONALISM

STATISTICS (1981)

	UNITS
JAPAN	25,000
U.S.A.	6,500
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D. JAPANESE NATIONALISM

LESSON PLAN #1

UNIT 1--ROBOT HISTORY AND ITS TREND

ASSIGNMENT SHEET 1

AFTER READING THE INFORMATION SHEET (IS1-1-1 AND IS1-1-4) PROVIDED, COMPLETE THE FOLLOWING QUESTIONS IN WRITING OR AS REQUESTED BY YOUR INSTRUCTOR.

1. WHY DID MOST AUTHORS CHOOSE THE YEAR 1923 AS A STARTING POINT OF ROBOT HISTORY?
   The year 1923 is not only chosen because it marks any significant advance in robot technology , but also because it marks the year that the word "robot" was introduced.

2. WHAT IS THE DIFFERENCE BETWEEN HARD AUTOMATION DEVICE AND ROBOTS?

   A hard automation device consists primarily of drive mechanisms controlled by devices such as timers, cams, switches, and mechanical and electrical stops.
   Robots can be seen as one kind of hard automation device, except the robots have the capability to do variations in its motions with Serno or computer control.

3. LIST FOUR REASONS THAT PRESENT THE USE AND DEVELOPMENT OF INDUSTRIAL ROBOT IN THE USA.
   1. High initial cost and extended payback periods.

   2. Labor's negative reaction to robots.

   3. Government's failure to recognize robots as a means of increasing the nation's productivity.

   4. Short-sighted managers in most US factories.

4. WHY ARE ROBOTS NOT A THREAT TO THE WORKERS IN JAPAN?
   Because most Japanese companies are guaranteed to their employee for life-time employment so they don't perceive robots as a threat to them.

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5. IN THE YEAR 1923 THE WORD "ROBOT" WAS INTRODUCED INTO THE ENGLISH VOCABULARY.

6. HARD AUTOMATION DEVICES ARE SELDOM ALTERED TO CHANGE THEIR OPERATION.

7. THE GREATEST ADVANCEMENT IN THE EVOLUATION OF THE ROBOT WAS THE ADAPTATION OF COMPUTER CONTROL.

8. THE JAPANESE HAVE BECOME WORLD LEADERS IN THE APPLICATION OF ROBOT TECHNOLOGY WITH NEARLY HALF OF THE WORLD'S ROBOTS WORKING IN ITS COUNTRY TODAY.

9. THE ROBOTIZATION OF U.S. INDUSTRY MEANS MORE THAN JUST INCREASED PRODUCTIVITY AND ITS POSITIVE ECONOMIC EFFECTS, THERE ARE ALSO THE SOCIAL CONSEQUENCES TO CONSIDER.

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Lesson Plan # 2

Course Title ROBOT SERVICE AND REPAIR Course # _____

Unit Title INTRODUCTION TO ROBOT Unit # 1

Technical Information Lesson X General /Guidance Information Lesson ____

OR

Job Skill Demonstration Lesson _____

SOCIO-ECONOMIC IMPACT OF ROBOT

LESSON TITLE

Lesson Objective - Upon Completion of This Lesson the Student Should Be Able To:

1. STATE THE EMPLOYMENT OF INDUSTRIAL ROBOTS IN DIFFERENT PRODUCTION SCENES.
2. DESCRIBE THE FUNCTIONS OF INDUSTRIAL ROBOTS.
3. COMPARE THE ROBOT COST WITH HUMAN LABOR COST.
4. EXPLAIN THE RELATIONSHIP AMONG MAN, ROBOT, AND SPECIAL AUTOMATION.

Tools and Materials:

Teaching Aids:

H1-2-1 SYLLABUS SHEET
T1-2-1 REASONS FOR USING ROBOTS FOR SELECTED APPLICATIONS
T1-2-2 A COMPARISON OF UNIT COSTS FOR MANUFACTURING METHODS BY LEVEL OF PRODUCTION
T1-2-3 THE FUNCTIONS OF INDUSTRIAL ROBOTS
T1-2-4 ROBOT COST vs. HUMAN COST
T1-2-5 MAN vs. ROBOT vs. SPECIAL AUTOMATION

Informational Assignment:

INFORMATION SHEETS

IS1-2-1 THE THREE CHARACTERISTICS OF INDIVIDUAL ROBOTS
IS1-2-2 THE EMPLOYMENT OF ROBOTS IN DIFFERENT PRODUCTION SCENES
IS1-2-3 THE REASONS FOR USING INDUSTRIAL ROBOTS
IS1-2-4 ROBOT COST vs. HUMAN COST

ANSWER QUESTIONS FOUND ON ASSIGNMENT SHEETS

AS1-2-1 SOCIO-ECONOMIC IMPACT OF ROBOT

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Individualized Informational Assignment for Special Students:

References:

1. DROF, RICHARD C., ROBOTICS AND AUTOMATED MANUFACTURING, RESTON PUBLISHING COMPANY, INC., 1983.
2. ENGELBERGER, JOSEPH F., ROBOTICS IN PRACTICE, AMERICAN MANAGEMENT ASSOCIATION, NEW YORK, 1980.

Step 1 - Introduction for Preparation of the Student:

PRODUCTIVITY IS ONE MAJOR GOAL OF THE INDUSTRIES OF TODAY. THIS GOAL IS NOT ONLY TO INCREASE THE COMPETIVENESS OF INDUSTRIES BUT ALSO TO IMPROVE ITS ECONOMIC EFFECTS.

IN ORDER TO ACHIEVE THE GOALS, THE INDUSTRIES HAVE RECOGNIZED THE APPLICATION OF ROBOT TECHNOLOGY AS AN IMPORTANT TOOL. THE USE OF ROBOTS MAY LOWER PRODUCTION COSTS, IMPROVE THE QUALITY OF PRODUCTS AND REDUCE WORKPLACE HAZARDS. A CLEAR THEME HAS BEEN THE CONCERN THAT FOREIGN COMPETITORS MAY BE GAINING A SIGNIFICANT EDGE OVER THE U.S., BOTH IN USING THIS NEW TECHNOLOGY AND IN ESTABLISHING A COMPETITIVE POSITION IN THE POTENTIALLY MAJOR EXPORT MARKET FOR ROBOTS.

IN THIS LESSON, THE STUDENT WILL UNDERSTAND THE REASONS FOR USING INDUSTRIAL ROBOTS, THEIR FUNCTIONS, AND BE ABLE TO COMPARE THE COSTS OF MAN, ROBOTS AND SPECIAL AUTOMATION.

Lesson Plan # 2

Course Title ROBOT SERVICE AND REPAIR Course # _____

Unit Title INTRODUCTION TO ROBOT Unit # 1

Lesson Title: SOCIO-ECONOMIC IMPACT OF ROBOTS

STEP 2 - Presentation Outline:

I. THE THREE CHARACTERISTICS OF INDUSTRIAL ROBOTS
   A. INDUSTRIAL ROBOTS, UNLIKE SPECIAL PURPOSE AUTOMATED MACHINES, ARE PROGRAMMABLE, AND AS A CONSEQUENCE, ARE BOTH FLEXIBLE AND VERSATILE. A ROBOTS' MOVEMENTS MAY BE ALTERED MERELY BY CHANGING ITS PROGRAM.
   B. INDUSTRIAL ROBOTS CAN PERFORM BEYOND THE PHYSICAL AND MECHANICAL ABILITIES OF HUMANS.
   C. INDUSTRIAL ROBOTS PERFORM WITH A HIGH FIDELITY AND ACCURACY IN COMPLIANCE WITH INSTRUCTION WHICH THEY RECEIVE FROM MAN.

II. THE EMPLOYMENT OF ROBOTS IN DIFFERENT PRODUCTION SCENES
   A. AUTOMATION OF MULTIPRODUCT SMALL BATCH AND MIXED-FLOW-PRODUCTION LINE.
   B. EASE OF PHASING IN PRODUCT DESIGN MODIFICATION AND MODEL DANGEROUS.
   C. IMPROVED OPERATING RATIO AND INCREASED OPERATING TIME.
   D. ABILITY TO WITHSTAND SEVERE WORKING CONDITIONS.
   E. ABILITY TO EXECUTE PROPER AND ACCURATE MOTION AND THE ABILITY TO COPE ELASTICALLY WITH CHANGING PRODUCTION VOLUME.
   F. CHANGE IN NATURE OF PRODUCTION SYSTEM.
   G. CREATION OF NEW TECHNOLOGIES.

III. THE REASONS FOR USING INDUSTRIAL ROBOTS
   A. IMPROVEMENT OF PRODUCTIVITY.
   B. STABILITY AND IMPROVEMENT IN PRODUCTION QUALITY.
   C. IMPROVEMENT IN PRODUCTION MANAGEMENT.
   D. HUMANIZATION OF WORKING LIFE.
   E. RESOURCE CONSERVATION.

IV. ROBOT COST vs. HUMAN COST

A. THE TREND OF INCREASED PAYMENTS TO WORKERS CONTINUES, SO THAT LABOR WHICH WAS ONCE REGARDED AS CHEAP NOW HAS TO BE PAID FOR AT RATES WHICH COMPENSATES FOR THE MONOTONY AND UNPLEASANT NATURE OF THE JOB.

B. ROBOT PAYBACK ANALYSIS

1. PAYBACK PERIOD.
2. RETURN ON INVESTMENT.
3. INTERNAL RATE OF RETURN.
4. TOTAL COST COMPARISONS.

V. MAN vs. ROBOT vs. SPECIAL AUTOMATION

A. REMOVING THE MAN FROM THE IMMEDIATE OPERATIONAL VICINITY CAN REDUCE THE NEEDS FOR SAFETY EQUIPMENT AND SAVE ITS COSTS. THESE ARE ALSO DRAMATIC REDUCTIONS IN LABOR COSTS, BECAUSE THERE IS NO LONGER ANY NEED FOR AN OPERATOR TO BE KEPT FULLY OCCUPIED AT THE MACHINE.

B. THE ROBOT INCREASES ITS NICHE IN INDUSTRY BY DRIVING A WEDGE BETWEEN MANUAL LABOR AND HARD AUTOMATION.

Lesson Plan # 2

Course Title ROBOT SERVICE AND REPAIR Course # _____

Unit Title INTRODUCTION TO ROBOT Unit # 1

STEP 3 - Classroom, Laboratory, Shop or Other Activities:

STEP 4 - Lesson Summary and Review Items to be Used to Evaluate the Lesson Against the Lesson Objective:

INTERACTION ITEMS:

1. WHAT ARE THE THREE CHARACTERISTICS OF THE INDUSTRIAL ROBOTS?

   1. Industrial robots are programmable and as a consequence, are both flexible and versatile.

   2. Industrial robots can perform beyond the physical and mechanical abilities of humans.

   3. Industrial robots perform with high fidelity and accuracy in compliance with the instruction which they receive from man.

2. EXPLAIN WHY A FIRM APPLIES INDUSTRIAL ROBOTS IN ITS PRODUCTION LINE TO IMPROVE OPERATING RATIO AND INCREASE OPERATING TIME?

   Industrial robots can operate on a 24-hour basis and therefore, the machines they service can also operate on a 24-hour basis. Furthermore, industrial robots are capable of performing functions at a high rate of speed which exceeds human limitations.

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3. WHAT ARE THE FUNCTIONS OF INDUSTRIAL ROBOTS?

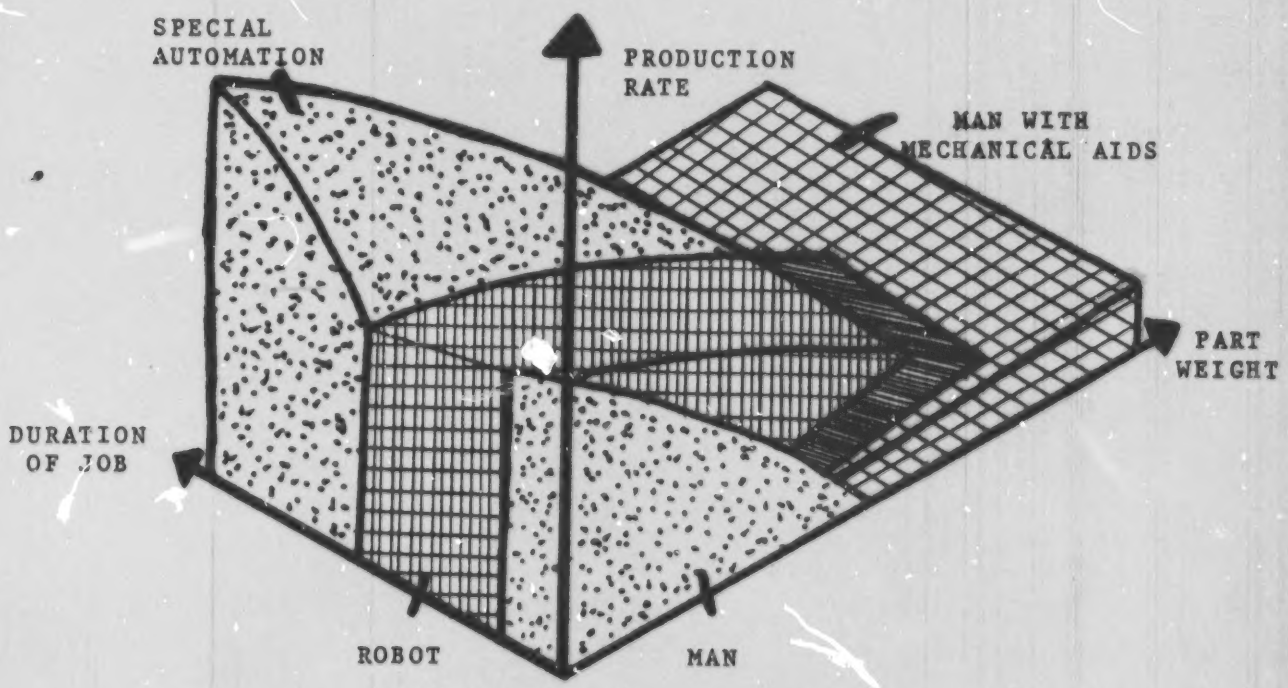
1. Improvement of productivity.
2. Stability and improvement in product quality.
3. Improvement in production management.
4. Humanization of working life.
5. Resource conservation.

4. COMPARE THE ROBOT COST WITH HUMAN LABOR COST.

Mid 60's------Human labor $\geq$\$4.00/hr. $\leq$Robot labor
1980----------Human labor $\geq$\$16.70/hrs.
Robot labor $\leq$\$4.80/hrs.
1982----------Human labor $\geq$\$20/hrs.
Robot labor $\leq$\$5.5/hrs.

5. DESCRIBE THE RELATIONSHIP AMONG MAN, ROBOT, AND SPECIAL AUTOMATION.

The relationship of these three items is shown as follows.



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Lesson Plan # 2

Course Title/No. ROBOT SERVICE AND REPAIR Course # _____

Unit Title INTRODUCTION TO ROBOT Unit # 1

Unit Test Items Oral, Written, or Performance:

I. TRUE-FALSE

F 1. ROBOTS REQUIRE BREAKS TO OVERCOME FATIGUE FROM LONG CONTINUING WORK.

T 2. THE FLEXIBILITY AND VERSATILITY OF INDUSTRIAL ROBOTS MAKE POSSIBLE THE AUTOMATION OF MULTI-PRODUCT SMALL BATCH AND MIXED-FLOW-LINE PRODUCTION.

T 3. THE INTRODUCTION OF INDUSTRIAL ROBOTS MEANS A CHANGE IN THE PRODUCTION SYSTEM.

F 4. THE NON-ECONOMIC FACTORS SUCH AS WORKER SAFETY AND HAZARDOUS CONDITIONS ARE NOT CITED AS THE MAIN REASONS FOR ADAPTING A ROBOT SYSTEM.

T 5. THE ABILITY TO SHORTEN THE CYCLE TIME FOR INTRODUCTION OF A NEW ROBOT SYSTEM IS MOST HIGHLY VALUED BY THE AUTOMOBILE INDUSTRY.

II. COMPLETION

1. INDUSTRIAL ROBOTS ARE programmable, UNLIKE SPECIAL PURPOSE AUTOMATED MACHINES.

2. INDUSTRIAL ROBOTS CAN OPERATE ON A 24 HOUR BASIS, THEREFORE, THEY CAN IMPROVE OPERATING RATIO AND INCREASE OPERATING TIME.

3. REDUCING DIRECT LABOR COSTS IS THE PRIMARY CONSIDERATIONS IN THE CASE OF welding, machinery, AND material handling.

4. ONE IMPORTANT IMPROVEMENT IN PRODUCTION MANAGEMENT IS reduction IN SET UP TIME AND elimination OF RETOOLING THE PRODUCTION LINE.

5. ROBOTS ARE MOST EFFECTIVE FOR batch OR medium QUANTITY PRODUCTION.

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IV. ANSWER THE QUESTIONS

1. WRITE FOUR REASONS WHY INDUSTRY IS EXPECTING TO USE ROBOTS TODAY.

The reasons are:

1. **induction in direct labor costs**
2. **increase in productivity**
3. **replacement of human labor in hazardous and unpleasant working environments**
4. **improving product quality**

2. WHAT KINDS OF RESOURCE SAVINGS WERE OBTAINED IN USING INDUSTRIAL ROBOTS?

These savings were achieved in a variety of ways:

1. **The robots saved material. For example, the paint spraying robot, used 20-30% less than the manual painter in many operations.**

2. **The ease of accommodating the robot to product design changes reduced investment in purchasing and/or rebuilding equipment.**

3. **The reduced defective ratio saved resources.**

4. **The industrial robot, by working in unpleasant environments, reduced the energy consumption of air conditioning, ventilation, lighting, etc.**

5. **By its ability to operate on one, two, or three shifts, the industrial robot resulted in reducing investment.**

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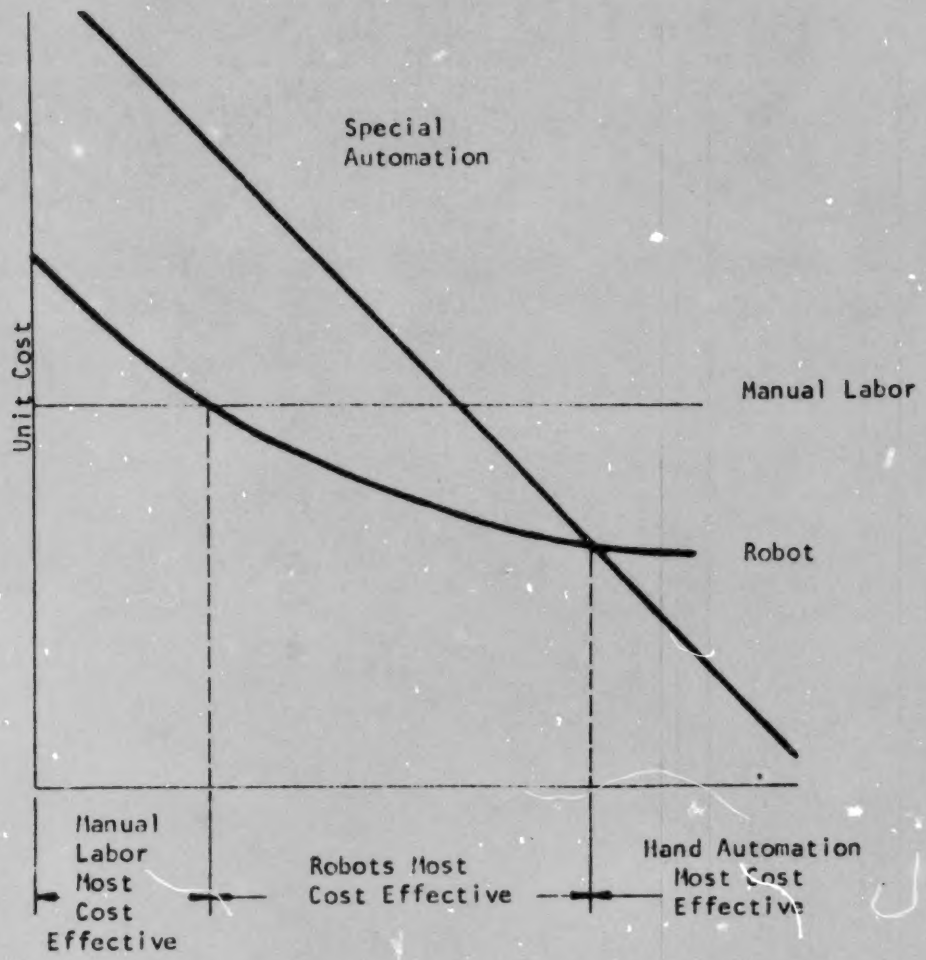
REASONS FOR USING ROBOTS FOR SELECTED APPLICATION

	REDUCTION IN DIRECT LABOR COSTS	INCREASE IN PRODUCTIVITY	HAZARDOUS, UNPLEASANT WORK	IMPROVED PRODUCT QUALITY
WELDING	1	2	4	3
MATERIAL HANDLING	1	3	2	4
MACHINING	1	2	4	3
MACHINE LOADING	2	1	3	4
ASSEMBLY	2	1	4	3
SPRAY PAINTING	3	4	1	2



PRODUCTION VOLUME PER YEAR
A COMPARISON OF UNIT COSTS FOR MANUFACTURING
METHODS BY LEVEL OF PRODUCTION

THE FUNCTIONS OF INDUSTRIAL ROBOTS

1. IMPROVEMENT OF PRODUCTIVITY
2. STABILITY AND IMPROVEMENT IN PRODUCT
3. IMPROVEMENT IN PRODUCTION MANGEMENT
4. HUMANIZATION OF WORKING LIFE
5. RESOURCE CONSERVATION

ROBOT COST VS. HUMAN LABOR COST

MID 60'S

HUMAN LABOR $\cong$ $\frac{\$4.00}{\text{HOUR}}$ $\cong$ ROBOT LABOR

1980

HUMAN LABOR $\Rightarrow$ $\frac{\$16.70}{\text{HOUR}}$

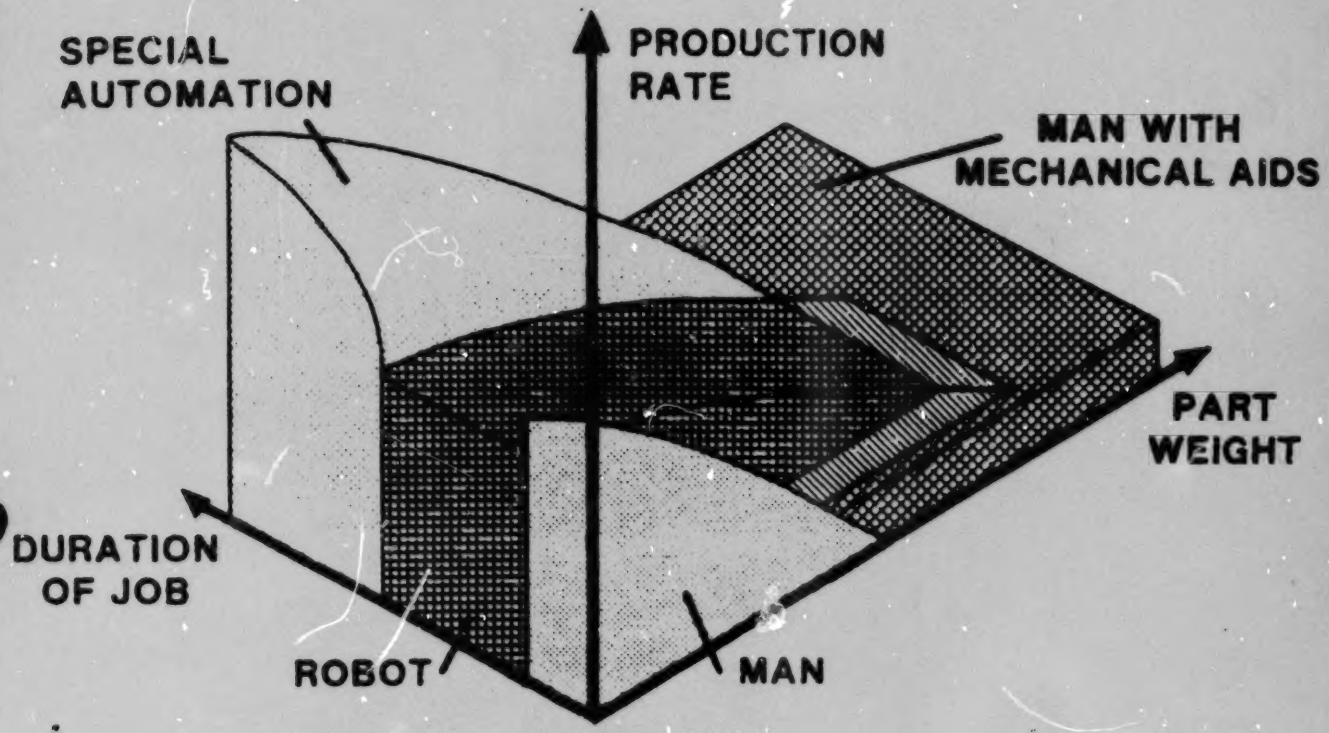
ROBOT LABOR $<$ $\frac{\$4.80}{\text{HOUR}}$

1982

HUMAN LABOR $\Rightarrow$ $\frac{\$20.00}{\text{HOUR}}$

ROBOT LABOR $<$ $\frac{\$5.50}{\text{HOUR}}$

MAN VS. ROBOT VS. SPECIAL AUTOMATION



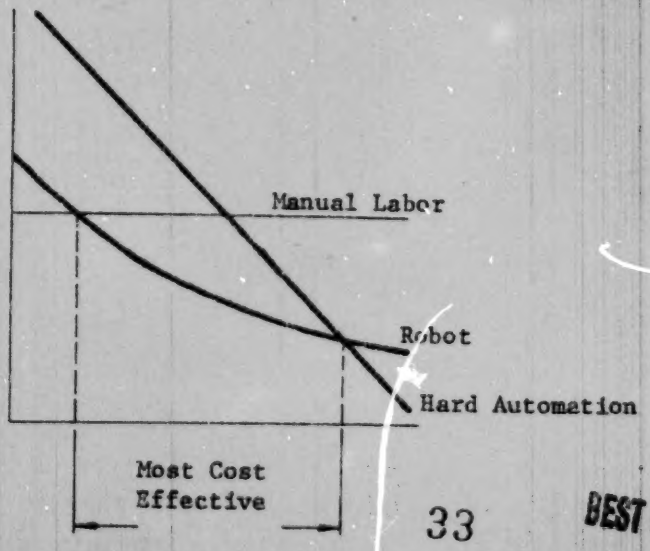
UNIT 1--INTRODUCTION TO ROBOTS

ASSIGNMENT SHEET 1

AFTER READING THE INFORMATION SHEETS (IS1-2-1, THROUGH (IS1-2-5) PROVIDED, COMPLETE THE FOLLOWING QUESTIONS IN WRITING OR AS REQUESTED BY YOUR INSTRUCTOR.

1. WHAT ARE THE MAJOR CHARACTERISTICS OF INDUSTRIAL ROBOTS IN DETERMINING SOCIO-ECONOMIC IMPACT?
   - A. Industrial robots are programmable and as a consequence, are both flexible and versatile.
   - B. Industrial robots can perform beyond the physical and mechanical abilities of humans.
   - C. Industrial robots perform with high fidelity and accuracy in compliance with the instructors which they receive from man.
2. WHAT ARE THE CONSIDERATIONS IN USING THE INDUSTRIAL ROBOTS?
   - A. Reduction in direct labor costs
   - B. Increasing productivity
   - C. Hazardous unpleasant work
   - D. Improving product quality
3. DRAW A DIAGRAM TO SHOW THE MOST EFFECTIVE QUANTITY OF PRODUCTION IN USING ROBOTS.

   Robots are most effective for batch or medium quantity production.



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4. EVEN THOUGH THE INITIAL COSTS OF ROBOTS ARE CONSIDERABLY HIGHER THAN THE HUMAN LABOR COSTS, WHY ARE INDUSTRIES STILL EXPECTED TO USE ROBOTS IN THEIR FACTORY?

Although the initial cost of a robot installation is considerably higher than that of hiring a new employee, the differential is easy offset by the average cost of robot operation as compared to the average renumeration of a skilled worker. In addition, employee's must undergo considerable retraining when switched from one job to another, while robots can be reprogrammed with little difficulty to accommodate production line changes. Besides that, the noneconomic factors such as worker safety and hazardous conditions are also often cited as the main reasons for adopting the robot system. This is why industry people expected to use robots instead of human labor.

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5. THE COSTS AND SAVINGS OF A TYPICAL ROBOT INSTALLATION ARE AS FOLLOWS: CALCULATE THE PAYBACK PERIODS AND THE TOTAL COST COMPARISONS.

PURCHASE PRICE--P=$50,000
ACCESSORIES AND EQUIPMENT--A=$20,000
ENGINEERING & INSTALLATION--I=$18,000
MAINTENANCE & OPERATION--O=$2/hr.
DIRECT & INDIRECT LABOR--L=$20/hr.
MATERIAL--M=$1/hr.
TAX CREDIT--C=$5,000
ANNUAL DEPRECIATION--D=$8,000 (6 years life)

GIVEN: P=$50,000 L=$20/hr. I=$18,000 O=$2/hr.
A=$20,000 M=$1/hr. C=$5,000 D=$8,000

Assume TR (the tax rate of the firm)=0.4.
H (hours of use during the year)=250 days x 8hrs. = 2,000 hrs.

A. Payback period (pp) = $\frac{(P+A+I)-C}{(L+M-O) \times H \times (I-TR)+D \times TR}$

$$pp = \frac{(50,000+20,000+18,000)-5,000}{(20+1-2) \times (2,000) \times (1-0.4)+(8,000 \times 0.4)}$$

$$= \frac{88,000-5,000}{22,800+3,200} = \frac{83,000}{26,000} = 3.19 \text{ years}$$

If the same system were used on two shifts, then H=250 x 16 = 4,000 hrs.

Therefore, we have: $pp = \frac{83,000}{19 \times 4,000 \times .6 + 3200}$

$$= \frac{83,000}{48,800} = 1.7 \text{ years.}$$

B. Total cost comparison. Assume a comparison period (Y) of five years with two shift operations. For the normal labor procedure the total cost (TCL) is:

$$TCL = H \times L \times Y$$
$$= 4,000 \times \$20 \times 5$$
$$= \$400,000$$

The total cost of the robot system (TCR) is calculated as:

$$TRC = (P+A+I-C)+ (O-M) \times H-D \times TR \times Y$$

Then we have:

$$TCR = (50,000+20,000+18,000-5,000)+ (2-1) \times 4,000-8,000 \times .4 \times 5$$
$$=83,000+(4,000-3,200) \times 5$$
$$=83,000-4,000$$
$$=\$79,000$$

So, total cost comparison will be:

$$E = \frac{TCL}{TCR} = \frac{400,000}{79,000} = 5.06$$

Over the selected five-year period the total cost of the labor system is almost five times that of the robot's system.

Lesson Plan # 3

Course Title ROBOT SERVICE AND REPAIR Course # _____

Unit Title INTRODUCTION TO ROBOT Unit # 1

Technical Information Lesson X General /Guidance Information Lesson ____

OR

Job Skill Demonstration Lesson _____

DEFINITION AND TERMINOLOGY OF ROBOTS

LESSON TITLE

Lesson Objective - Upon Completion of This Lesson the Student Should Be Able To:

1. VERBALLY DESCRIBE THE ROBOTIC DEFINITIONS IN RIA AND JIRA.
2. VERBALLY EXPLAIN THE TERMS WHICH WILL BE USED IN THIS COURSE.

Tools and Materials:

Teaching Aids:

H1-3-1	SYLLABUS SHEET
T1-3-1	DEFINITION OF ROBOTS: WEBSTER'S SEVENTH NEW COLLEGIATE DICTIONARY
T1-3-2	DEFINITION OF ROBOTS: RIA
T1-3-3	DEFINITION OF ROBOTS: JIRA
T1-3-4	FIVE AXES ROBOTS

Informational Assignment:

IS1-3-1	DEFINITION OF ROBOTS
IS1-3-2	TERMINOLOGY OF ROBOTS
	ANSWER QUESTIONS FOUND ON ASSIGNMENT SHEET
AS1-3-1	DEFINITION AND TERMINOLOGY OF ROBOTS

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Individualized Informational Assignment for Special Students:

References:

1. CONDON, MARY, STRAIGHT TALK ABOUT ROBOTS, TRAINING AND DEVELOPMENT JOURNAL, NOV. 1983, PP. 15-24.

2. DORF, RICHARD C., ROBOTICS AND AUTOMATED MANUFACTURING, RESTON PUBLISHING COMPANY, INC. RESTON, VIRGINIA, 1983.

Step 1 - Introduction for Preparation of the Student:

IT IS DIFFICULT TO ESTABLISH A USABLE, GENERALLY AGREED ON DEFINITION OF A ROBOT. EXPERTS USE DIFFERENT APPROACHES TO DEFINING THE TERM. IN ORDER TO DEFINE THE STATE OF THE ART, TO PROJECT FUTURE CAPABILITIES, AND TO COMPARE EFFORTS BETWEEN COUNTRIES, IT IS IMPORTANT TO HAVE SOME COMMON UNDERSTANDING OF THE TERMS IN THE INDUSTRIAL ROBOTS AREA.

IN THIS LESSON, THE STUDENT WILL BE FAMILIAR WITH RIA, JIRA DEFINITIONS OF ROBOTS AND UNDERSTAND THE BASIC TERMS OF INDUSTRIAL ROBOTS.

Lesson Plan # 3

Course Title ROBOTS SERVICE AND REPAIR Course # _____

Unit Title INTRODUCTION TO ROBOT Unit # 1

Lesson Title: DEFINITION AND TERMINOLOGY OF ROBOTS

STEP 2 - Presentation Outline:

I. DEFINITION

A. RIA - THE ROBOT INSTITUTE OF AMERICA (RIA) DEFINES A ROBOT AS "A ROBOT IS A PROGRAMMABLE MULTIFUNCTIONAL MANIPULATOR DESIGNED TO MOVE MATERIAL, PARTS, TOOLS, OR SPECIALIZED DEVICES, THROUGH VARIABLE PROGRAMMED MOTIONS FOR THE PERFORMANCE OF A VARIETY OF TASKS".

B. JIRA - ACCORDING TO JAPAN INDUSTRIAL ROBOT INDUSTRY ASSOCIATION (JIRA), THE ROBOTS ARE CLASSIFIED BY THE METHOD OF INPUT INFORMATION AND TEACHING AS FOLLOWS:

1. MANUAL MANIPULATOR
2. FIXED SEQUENCE ROBOT
3. VARIABLE SEQUENCE ROBOT
4. PLAYBACK ROBOT
5. NUMERICAL CONTROL (NC) ROBOT
6. INTELLIGENT ROBOT

C. INDUSTRIAL ROBOTS HAVE THREE PRINCIPAL COMPONENTS

1. ONE OR MORE ARMS
2. A MANIPULATOR
3. A CONTROLLER .

D. COMPUTER SCIENTISTS ADD A FEW CAPABILITIES TO THE GENERAL INDUSTRIAL ROBOTS THAT WILL BE THE SPECIALIZED ROBOTS

1. LOCOMOTION
2. PERCEPTION
3. HEURISTIC PROBLEM-SOLVING

II. TERMINOLOGY

A. AXES - THE AXES ARE ALSO KNOWN AS "DEGREE OF FREEDOM". THE NUMBER OF INTRICATE MOTIONS A ROBOT CAN PERFORM IS DETERMINED BY THE NUMBER OF AXES THE ROBOT HAS.

B. MANIPULATOR - A SYSTEM OF MECHANICAL LINKAGES AND JOINTS THAT CAN BE MOVED IN VARIOUS DIRECTIONS TO PERFORM THE WORK OF THE ROBOT.

C. ACTUATORS - THE DRIVE MECHANISMS THAT POSITION THE MANIPULATOR TO A PREDETERMINED POINT. THESE ACTIVATORS CAN BE PNEUMATIC OR HYDRAULIC CYLINDERS, PNEUMATIC OR HYDRAULIC ROTARY MOTORS AND ELECTRIC MOTORS.

D. GRIPPER - A HAND-LIKE DEVICE, SOMETIMES REFERRED TO AS THE "END EFFECTOR". IT HOLDS THE TOOL DOING THE WORK OR HANDLES THE MATERIAL BEING PROCESSED. MOST GRIPPERS ARE ACTIVATED HYDRAULICALLY, PNEUMATICALLY, MECHANICALLY, OR WITH ELECTRIC MOTORS.

E. CONTROLLER - THE BRAINS AND NERVOUS SYSTEM OF THE ROBOT. POWER SUPPLY - PROVIDES AND REGULATES THE ENERGY FOR ROBOT'S ACTUATORS. THIS ENERGY CAN BE PNEUMATIC, HYDRAULIC, ELECTRICAL, ELECTRO-HYDRAULIC, AND IN SOME CASES EVEN MECHANICAL.

Lesson Plan # 3

Course Title ROBOT SERVICE AND REPAIR Course # _____

Unit Title INTRODUCTION TO ROBOT Unit # 1

STEP 3 - Classroom, Laboratory, Shop or Other Activities:

STEP 4 - Lesson Summary and Review Items to be Used to Evaluate the Lesson Against the Lesson Objective:

INTERACTIVE ITEMS:

1. WHAT DO RIA AND JIRA STAND MEAN?

   RIA - Stands for The Robot Institute of America

   JIRA - Stands for The Japan Industrial Robot Industry Association

2. ACCORDING TO JIRA HOW MANY KINDS OF ROBOTS HAVE THEY DEFINED?

   Six. Manual manipulator, Fixed sequence robot, Variable sequence robot, Playback robot, Numerical control (NC) robot, and Intelligent robot.

3. WHAT IS MEANT BY DEGREE OF FREEDOM?

   The axes.

4. WHAT DOES THE END EFFECTOR MEAN?

   It's also known as the Gripper. It's a hand-like device which holds the tool doing the work or handles the material being processed.

5. HOW MANY KINDS OF ENERGY DO WE USE FOR ROBOTICS POWER SUPPLY?

   Five. Pnuematic, hydraulic, electrical, electro-hydraulic, and in some cases even mechanical.

Lesson Plan # 3

Course Title/No. ROBOT SERVICE AND REPAIR Course # _____

Unit Title INTRODUCTION TO ROBOTS Unit # 1

Unit Test Items **Oral, Written, or Performance:**

TRUE-FALSE

T 1. IN RIA DEFINITION, THE 'PROGRAMMABLE" AND "MULTI-FUNCTIONAL" ARE THE KEY WORDS FOR ROBOTIC CHARACTERISTICS.

F 2. A MANUAL MANIPULATOR CAN PERFORM A GIVEN TASK ACCORDING TO THE SEQUENCE, CONDITIONS AND POSITION VIA PRESTORED DATA.

T 3. THE NUMBER OF AXES A ROBOT HAS DETERMINES THE COMPLEXITY OF A TASK THE ROBOT CAN PERFORM.

F 4. A SYSTEM OF MECHANICAL LINKAGES AND JOINTS THAT CAN BE MOVED IN VARIOUS DIRECTIONS TO PERFORM WORK ARE THE GRIPPERS.

T 5. THE ENERGY OF ROBOTIC POWER SUPPLY CAN BE PNEUMATIC, HYDRAULIC, ELECTRICAL AND ELECTRO-HYDRAULIC.

COMPLETION.

1. A ROBOT IS A programmable multifunctional MANIPULATOR DESIGNED TO WORK FOR HUMAN BEINGS.
2. ACCORDING TO JIRA, THE ROBOTS ARE CLASSIFIED BY THE METHOD OF input information AND teaching.
3. AN INDUSTRIAL ROBOT HAS THREE BASIC COMPONENTS. THEY ARE one or more arms, a manipulator, AND a controller.
4. THE NUMBER OF axes/degree of freedom A ROBOT HAS, DETERMINES THE COMPLEXITY OF A TASK THE ROBOT CAN PERFORM.
5. THE activator DRIVES THE ROBOT TO A PREDETERMINED POSITION.

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ANSWER THE QUESTIONS

1. SIMPLY DESCRIBE WHAT ARE THE DIFFERENCES BETWEEN FIXED AND VARIABLE SEQUENCE ROBOTS.

Fixed sequence robots - perform successive steps of a given operation according to a predetermined sequence, condition, and position and whose set information can not be easily changed.

Variable sequence robots - reverse of fixed sequence robots, all the predetermined operation and information can be easily changed.

2. COMPARE RIA WITH JIRA'S DEFINITION OF ROBOTS AND EXPLAIN WHAT IS THE DIFFERENCE BETWEEN THEM?

The only difference is the RIA definition of robots eliminates the manual manipulators and fixed sequence machines.

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DEFINITION OF ROBOTS

WEBSTER'S SEVENTH NEW COLLEGIATE DICTIONARY:
A ROBOT IS DEFINED AS "AN AUTOMATIC APPARATUS OR DEVICE THAT PERFORMS FUNCTIONS ORDINARILY ASCRIBED TO HUMAN BEINGS OR OPERATES WITH WHAT APPEARS TO BE ALMOST HUMAN INTELLIGENCE".

DEFINITION OF ROBOTS

RIA:

"A ROBOT IS A PROGRAMMABLE MULTIFUNCTIONAL MANIPULATOR DESIGNED TO MOVE MATERIAL, PARTS, TOOLS, OR SPECIALIZED DEVICES, THROUGH VARIABLE PROGRAMMED MOTIONS FOR THE PERFORMANCE OF A VARIETY OF TASKS."

DEFINITION OF ROBOTS

JIRA:

JAPAN CLASSIFIES INDUSTRIAL ROBOTS BY THE METHOD OF INPUT INFORMATION AND TEACHING AS FOLLOWS:

1. MANUAL MANIPULATOR
2. FIXED SEQUENCE ROBOT
3. VARIABLE SEQUENCE ROBOT
4. PLAY BACK ROBOT
5. NUMERICAL CONTROL (NC) ROBOT
6. INTELLIGENT ROBOT

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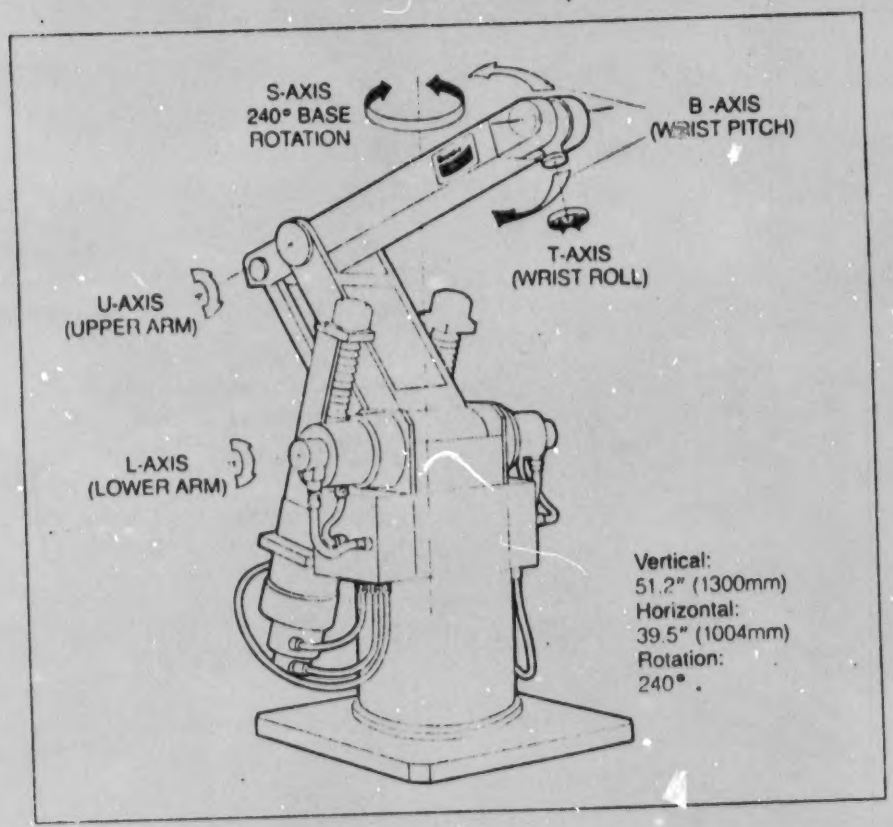
FIVE AXES ROBOT



LESSON PLAN #3

UNIT 1 - INTRODUCTION TO ROBOTS

ASSIGNMENT SHEET 1

AFTER READING THE INFORMATION SHEETS (IS1-3-1 AND IS1-3-2) PROVIDED, COMPLETE THE FOLLOWING QUESTIONS IN WRITING OR AS REQUESTED BY YOUR INSTRUCTOR.

1. ACCORDING TO RIA, DEFINE WHAT ARE ROBOTS?

A robot is a programmable, multifunctional manipulator designed to move material, parts, tools, or specialized devices, through variable programmed motions for the performance of a variety of tasks.

2. EXPLAIN WHAT IS THE DIFFERENCE BETWEEN FIXED SEQUENCE ROBOT AND VARIABLE SEQUENCE ROBOT?

The information that predetermined sequence, condition, and position of a fixed sequence robot can not be changed, but in variable sequence robot the set information can be easily changed.

3. WHAT IS INTELLIGENT ROBOT?

Intelligent robot is a robot using sensory perception (visual and/or tactile) to independently detect changes in the work environment or work condition and by its own decision making facility, proceeds with its operation accordingly.

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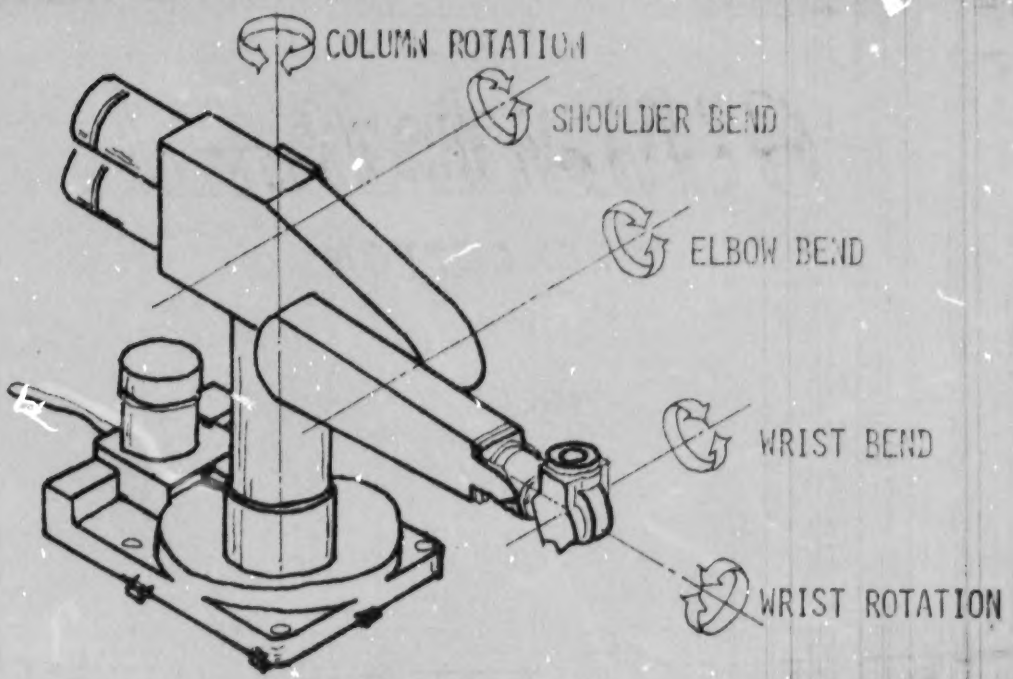
4. SIMPLY MAKE A DRAWING TO SHOW A FIVE AXES ROBOT.



5. WHAT IS AN ACTUATOR? HOW MANY KINDS ARE THERE?

Actuators are the drive mechanisms that position the manipulator to a predetermined point. The actuator can be:

--Pneumatic cylinders
--Hydraulic cylinders
--Pneumatic motors
--Hydraulic motors
--Electric motors

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Lesson Plan # 4

Course Title ROBOT SERVICE AND REPAIR Course # _____

Unit Title INTRODUCTION TO ROBOTS Unit # 1

Technical Information Lesson X General /Guidance Information Lesson ____

OR

Job Skill Demonstration Lesson _____

ROBOT CLASSIFICATION

LESSON TITLE

Lesson Objective - Upon Completion of This Lesson the Student Should Be Able To:

1. VERBALLY CLASSIFY THE ROBOTS BY GENERATION, MOTION, CONTROL SYSTEM, DRIVING SYSTEM AND TECHNOLOGY LEVELS.
2. VERBALLY DESCRIBE THE OPERATING SEQUENCE OF THE DIFFERENT CONTROLLED ROBOTS.
3. LIST THE TASKS ASSIGNED IN THE DIFFERENT TECHNOLOGY LEVELS OF A ROBOT.

Tools and Materials:

Teaching Aids:

H1-4-1 SYLLABUS SHEET
T1-4-1 ROBOT CLASSIFIED BY GENERATION
T1-4-2 ROBOT CLASSIFIED BY MOTION
T1-4-3 OPERATING SEQUENCE OF A NON-SERVO CONTROLLED SYSTEM
T1-4-4 OPERATING SEQUENCE OF A SERVO CONTROLLED SYSTEM
T1-4-5 DRIVEN SYSTEM

Informational Assignment:

INFORMATION SHEETS
IS1-4-1 CLASSIFIED BY GENERATION
IS1-4-2 CLASSIFIED BY MOTIONS
IS1-4-3 CLASSIFIED BY CONTROL SYSTEMS
IS1-4-4 CLASSIFIED BY DRIVING SYSTEMS
IS1-4-5 CLASSIFIED BY TECHNOLOGY LEVELS
ANSWER QUESTIONS FOUND ON ASSIGNMENT SHEETS
AS1-4-1 ROBOT CLASSIFICATION

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References:

1. TVER, DAVID F. AND BOLZ, ROGER W.; ROBOTICS SOURCEBOOK AND DICTIONARY, INDUSTRIAL PRESS INC., 1983

2. ENGELBERGER, J.F.: ROBOTICS IN PRACTICE, AMERICAN MANAGEMENT ASSOCIATION, NEW YORK, 1980

Step 1 - Introduction for Preparation of the Student:

TO UNDERSTAND ROBOTS, YOU NEED TO FAMILIARIZE BETTER WITH ALL OF THE DIFFERENT KINDS OR CATEGORIES OF ROBOTS. FOR EXAMPLE, ROBOT CAPABILITIES RANGE FROM VERY SIMPLE REPETITIVE POINT TO POINT MOTION, TO EXTREMELY VERSATILE MOVEMENTS THAT CAN BE CONTROLLED AND SEQUENCED BY A COMPUTER AS A COMPLETE INTEGRATED MANUFACTURING SYSTEM.

IN THIS UNIT, THE STUDENT WILL LEARN AND KNOW THAT THE ROBOTS WILL BE CLASSIFIED BY GENERATIONS, MOTIONS, CONTROL SYSTEMS, DRIVING SYSTEMS AND ITS TECHNOLOGY LEVELS, FROM WHICH THE STUDENT WILL BE ABLE TO KNOW AND CHOOSE SOME APPROPRIATE TYPES AND FUNCTIONS OF ROBOTS FOR USE IN TYPICAL INDUSTRIAL AREAS. THEY WILL ALSO BE INTRODUCED TO ROBOTICS OPERATING SEQUENCE AND RELATED FUNCTIONS.

Lesson Plan # 4

Course Title ROBOT SERVICE AND REPAIR Course # _____

Unit Title INTRODUCTION TO ROBOTS Unit # 1

Lesson Title: ROBOT CLASSIFICATION

STEP 2 - Presentation Outline:

I. CLASSIFIED BY GENERATIONS: (T1-4-1).
   A. GENERATION 1 ROBOT.
   B. GENERATION 2 ROBOT.
   C. GENERATION 3 ROBOT.
   D. GENERATION 4 ROBOT.

II. CLASSIFIED BY MOTIONS: (T1-4-2)
   A. BANG-BANG ROBOT.
   B. POINT TO POINT ROBOT.
   C. CONTINUOUS PATH ROBOT.

III. CLASSIFIED BY CONTROL SYSTEMS.
   A. NON-SERVO CONTROLLED ROBOTS (T1-4-3).
   B. SERVO CONTROLLED ROBOTS (T1-4-4).

IV. CLASSIFIED BY DRIVING SYSTEMS: (T1-4-5).
   A. DRIVE SYSTEMS.
   B. PNEUMATIC SYSTEMS.
   C. ELECTRICAL SYSTEMS.
   D. HYDRAULIC SYSTEMS.

V. CLASSIFIED BY TECHNOLOGY LEVELS.
   A. LOW-TECHNOLOGY LEVEL.
   B. MEDIUM-TECHNOLOGY LEVEL.
   C. HIGH-TECHNOLOGY LEVEL.

Lesson Plan # 4

Course Title ROBOT SERVICE AND REPAIR Course # _____

Unit Title INTRODUCTION TO ROBOTS Unit # 1

STEP 3 - Classroom, Laboratory, Shop or Other Activities:

STEP 4 - Lesson Summary and Review Items to be Used to Evaluate the Lesson Against the Lesson Objective

INTERACTION ITEMS:

1. HOW MANY GENERATIONS OF ROBOTS HAVE WE DISCUSSED AND WHICH GENERATION ARE WE USING IN INDUSTRY TODAY?

   There are four generations of robots which are: generation 1 robot, generation 2 robot, generation 3 robot, generation 4 robot.

   The robots we use in industry today, are generation 1.

2. WHAT IS A "BANG-BANG" ROBOT?

   A "Bang-Bang" robot is the simplest kind of controlled robot, which motions are controlled by driving each axis (degree of freedom) against a mechanical stop. As fixed stop machines, each of its axes has a fixed limit at each end of its stroke and cannot stop except at one or another of these limits.

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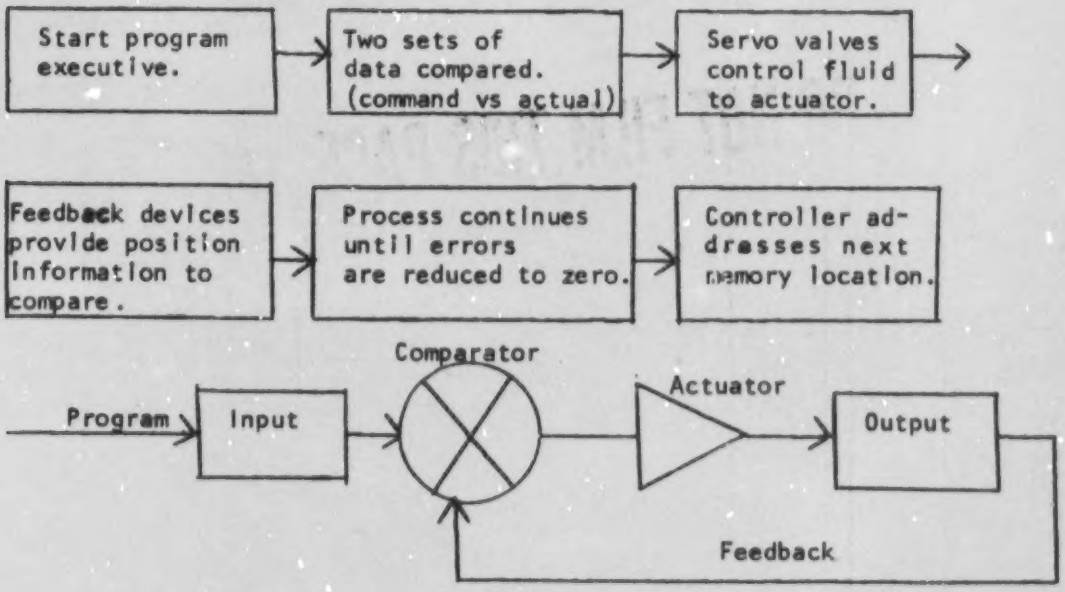
3. DRAW A DIAGRAM TO SHOW THE OPERATING SEQUENCE OF SERVO-CONTROLLED ROBOTS.



4. HOW MANY KINDS OF DRIVING SYSTEMS ARE USED IN ROBOTICS INDUSTRY TODAY? Four. Electrical system, Pneumatic system, Hydraulic system, and Combination of Hydraulic System.

5. ACCORDING TO THE CLASSIFICATION OF THE TECHNOLOGY LEVEL OF ROBOTS, THE TASK OF SPRAY PAINTING OPERATIONS AND MEASURING INSPECTION BELONG TO WHICH LEVELS?

Both of these operations need three or more degree of freedom with the continuous path controller. So, they belong to the High Technology Level.

Lesson Plan # 4

Course Title/No. ROBOT SERVICE AND REPAIR Course # _____

Unit Title INTRODUCTION TO ROBOTS Unit # 1

Unit Test Items **Oral, Written, or Performance:**

TRUE-FALSE

T 1. IN THE NEAR FUTURE, THE ROBOT WILL SEE OBJECTS AND BE ABLE, WITH HAND INTERACTIONS, TO PERFORM MANIPULATOR FUNCTIONS.

F 2. CONTINUOUS PATH CONTROL ROBOTS ARE USED WHERE THE FINAL POSITION IS VERY IMPORTANT AND THE PATH AND VELOCITY BETWEEN THE POSITIONS ARE NOT IMPORTANT.

T 3. NON-SERVO CONTROLLED ROBOTS ARE ALSO NAMED "PICK AND PLACE", "BANG-BANG", AND "LIMITED SEQUENCE" ROBOTS.

T 4. GENERALLY, THE SIZE OF THE MANIPULATOR ON THE NON-SERVO CONTROLLED ROBOTS IS SMALL.

F 5. CONTINUOUS PATH SERVO CONTROLLED ROBOTS ARE USUALLY LIMITED IN PROGRAMMING/POSITIONING FLEXIBILITY.

T 6. PN MATIC DRIVES HAVE THE MERIT OF BEING CHEAPER THAN OTHER METHODS.

F 7. HYDRAULIC SYSTEMS USUALLY WORK WITH SMALL ROBOTS.

F 8. HYDRAULIC DRIVEN ROBOTS POSSESS BETTER ACCURACY AND REPEATABILITY THAN ELECTRICAL DRIVEN SYSTEMS.

T 9. HIGH-TECHNOLOGY LEVEL ROBOTS HAVE MORE DEGREE OF FREEDOM THAN LOW LEVEL ROBOTS.

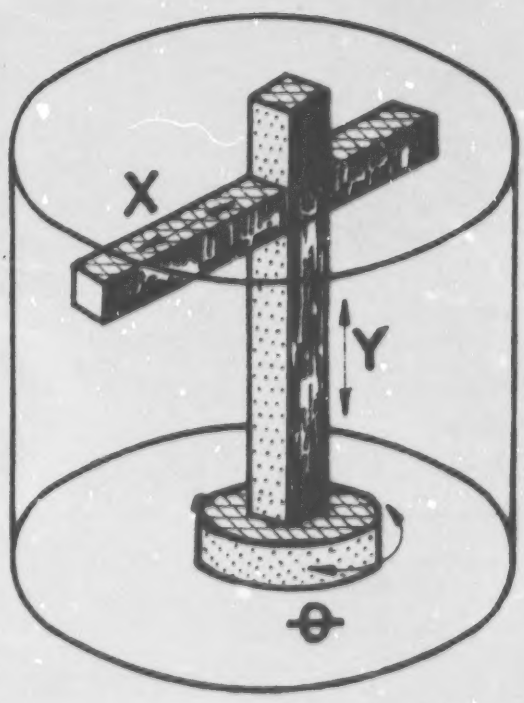
T 10. THE PAYLOAD CAPABILITIES OF SIMPLE ROBOTS ARE USUALLY LESS THAN MEDIUM- OR HIGH-TECHNOLOGY ROBOTS.

COMPLETION

1. GENERATION 1 ROBOT IS A KIND OF ROBOT THAT IS USED THE MOST TODAY.
2. GENERATION 3 ROBOTS WILL BE THE FUTURE ROBOTS THAT WILL HAVE EYE AND HAND COORDINATION CONTROL THROUGH THEIR VISION CONTROL SYSTEM.
3. A FACTOR INTELLIGENCE CONTROLLED ROBOT PROVIDES ARTIFICIAL INTELLIGENCE TO HELP AND SOLVE FACTORY PROBLEMS.

4. ROUGHLY, 50% OF THE MARKET IN INDUSTRIAL ROBOTS IS A POINT TO POINT ROBOT.
5. IN A POINT TO POINT SERVO CONTROLLED ROBOT, THE END STOPS CAN BE SET OR TAUGHT ANYWHERE IN A GIVEN AXIS.
6. WHEN A ROBOT IS BEING CONTROLLED BY A CONTINUOUS PATH SERVO CONTROL, A LARGE AMOUNT OF CONTROLLER MEMORY IS REQUIRED.
7. ROBOT DRIVE SYSTEMS CAN BE ELECTRICAL, PNEUMATIC, HYDRAULIC AND A COMBINATION OF THESE.
8. A PNEUMATIC SYSTEM DOES NOT MAKE FOR EASY CONTROL OF EITHER SPEED OR POSITION.
9. ELECTRICAL DRIVEN ROBOTS DON'T HAVE THE HIGH STRENGTH AND SPEED OF HYDRAULIC ROBOTS.
10. THERE ARE THREE CATEGORIES OF INDUSTRIAL ROBOTS CLASSIFIED BY TECHNOLOGY LEVELS WHICH ARE LOW, MEDIUM, AND HIGH TECHNOLOGY LEVELS.
11. SERVO CONTROLS ARE FEEDBACK DEVICES THAT GENERATE POSITION SIGNALS.
12. SERVO CONTROL SYSTEMS COMPARE THE INPUT SIGNAL (COMMAND) TO THE OUTPUT SIGNAL.

CYLINDRICAL COORDINATE SYSTEM
(X, Y, θ): Z LINEAR AXES
1 ROTATIONAL AXES



CLASSIFIED BY GENERATION

A. GENERATION 1 ROBOT
   --MOSTLY USED TODAY.
   --PROGRAMMABLE.
   --SEVERAL DEGREE OF FREEDOM.

B. GENERATION 2 ROBOT
   --KEEP THE FUNCTIONS OF GENERATION 1 ROBOT.
   --ADD SENSORY CONTROL CAPABILITIES.

C. GENERATION 3 ROBOT
   --RETAIN THE CAPABILITIES OF PREVIOUS GENERATION ROBOT.
   --ADD VISION CONTROL SYSTEM.

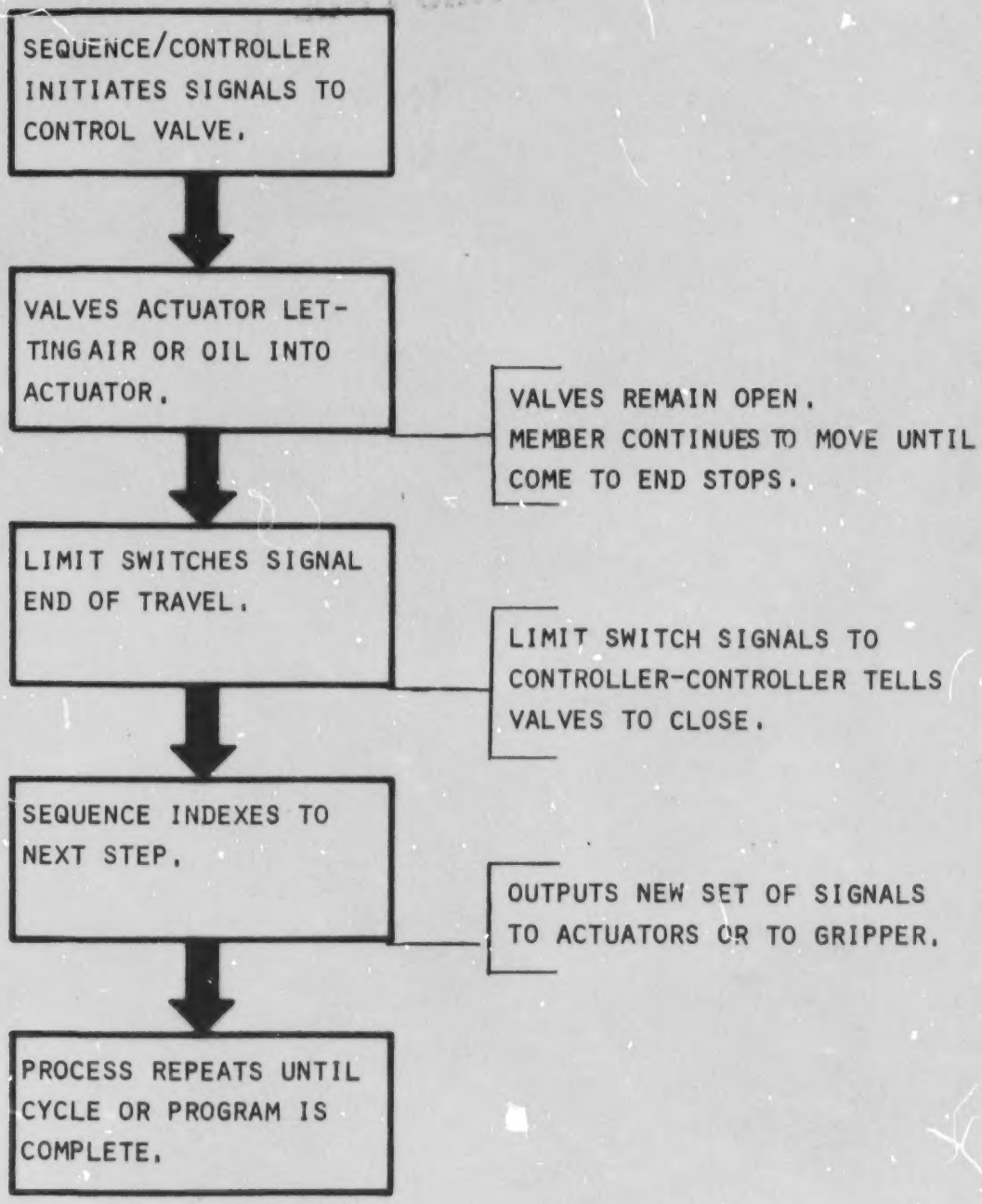
D. GENERATION 4 ROBOT
   --FACTOR INTELLIGENT CONTROLLED ROBOT.
   --ARTIFICIAL INTELLIGENCE.

CLASSIFIED BY MOTION

A. BANG-BANG ROBOT
   --MOTION LIMITED IN ONE AXIS.
   --LIMITED SEQUENCE.
   --PICK AND PLACE.
   --END POINT.

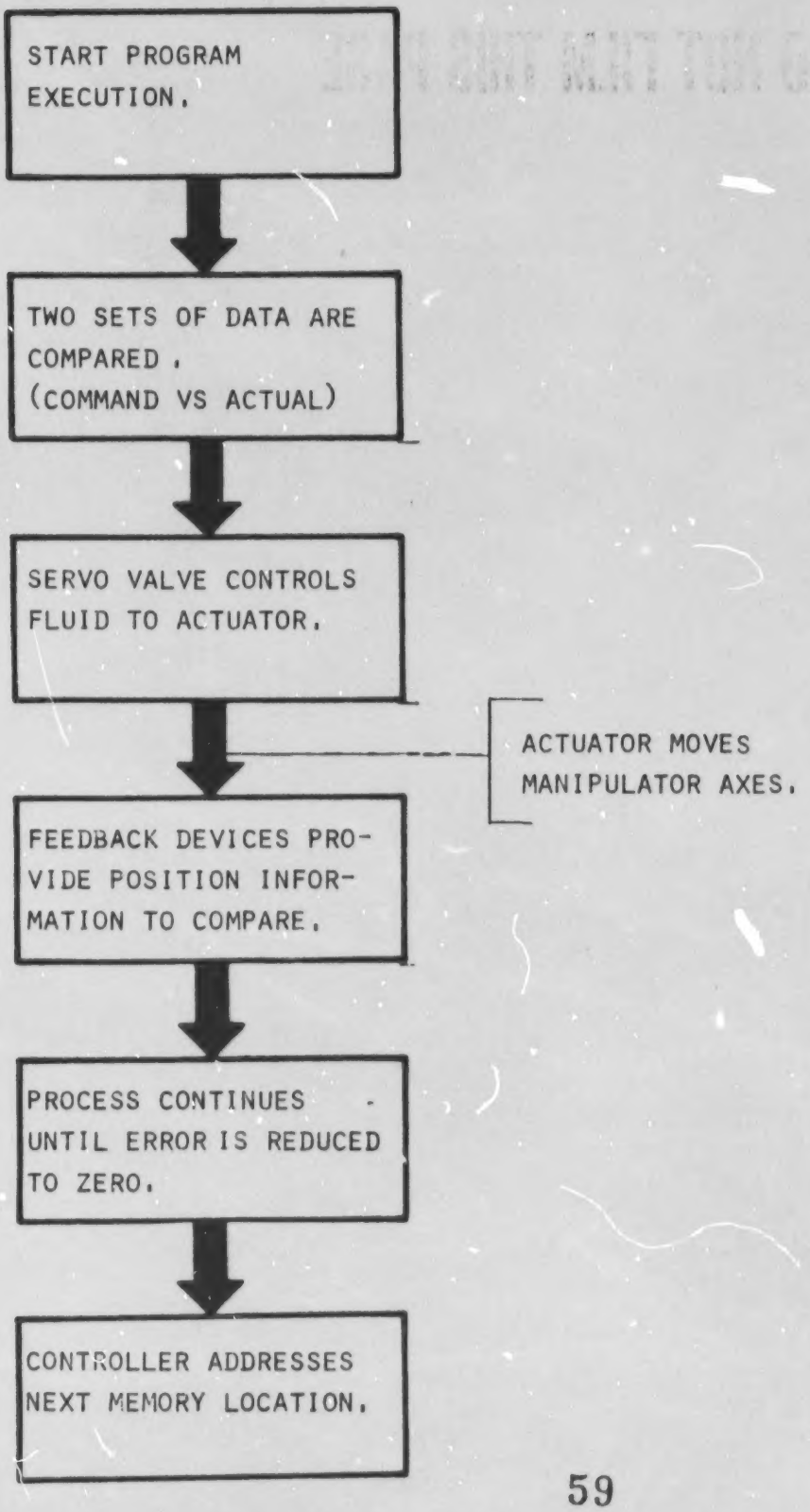
B. POINT TO POINT ROBOT
   --PATH AND VELOCITY BETWEEN POINTS ARE NOT IMPORTANT.

C. CONTINUOUS PATH ROBOT
   --ROBOT OPERATES THROUGH AN INFINITE NUMBER OF POINTS IN SPACE. LINEAR OR CIRCULAR PATH.


SEQUENCE/CONTROLLER INITIATES SIGNALS TO CONTROL VALVE.
VALVES ACTUATOR LET-TING AIR OR OIL INTO ACTUATOR.
VALVES REMAIN OPEN. MEMBER CONTINUES TO MOVE UNTIL COME TO END STOPS.
LIMIT SWITCHES SIGNAL END OF TRAVEL.
LIMIT SWITCH SIGNALS TO CONTROLLER-CONTROLLER TELLS VALVES TO CLOSE.
SEQUENCE INDEXES TO NEXT STEP.
OUTPUTS NEW SET OF SIGNALS TO ACTUATORS OR TO GRIPPER.
PROCESS REPEATS UNTIL CYCLE OR PROGRAM IS COMPLETE.

OPERATING SEQUENCE OF NON-SERVO CONTROLLED SYSTEM

OPERATING SEQUENCE OF SERVO-CONTROLLED SYSTEM


START PROGRAM EXECUTION.
TWO SETS OF DATA ARE COMPARED. (COMMAND VS ACTUAL)
SERVO VALVE CONTROLS FLUID TO ACTUATOR.
ACTUATOR MOVES MANIPULATOR AXES.
FEEDBACK DEVICES PROVIDE POSITION INFORMATION TO COMPARE.
PROCESS CONTINUES UNTIL ERROR IS REDUCED TO ZERO.
CONTROLLER ADDRESSES NEXT MEMORY LOCATION.

DRIVEN SYSTEM

A. PNEUMATIC SYSTEMS

--30%
--CHEAP
--EASY CONTROL (SPEED OR POSITION)
--MORE FAMILIAR TO SHOP PERSONNEL

B. HYDRAULIC SYSTEMS

--MOST POPULAR
--MAKE MECHANICAL SIMPLICITY
--MAINTAIN HIGH STRENGTH AND SPEED
--MORE ACCURACY CONTROL

C. ELECTRICAL SYSTEM

--20%
--GOOD ACCURACY AND REPEATABILITY
--LESS FLOOR SPACE

D. COMBINATION

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LESSON PLAN #4

UNIT 1 - INTRODUCTION TO ROBOTS

ASSIGNMENT SHEET 1

AFTER READING THE INFORMATION SHEETS (IS1-4-1 THROUGH IS1-4-5) PROVIDED, COMPLETE THE FOLLOWING QUESTIONS IN WRITING OR AS REQUESTED BY YOUR INSTRUCTOR.

1. WHAT IS MEANT BY THE SENSORY CONTROLLED ROBOT?

   The sensory controlled robot is a robot that has the capabilities to perform, "make" and "test" functions. It will work on principles of electro-optics, pressure, torque, force-sensitive touch, and proximity. It will be capable of recognizing and manipulating workpieces, parts and tools.

2. LIST FOUR APPLICATIONS OF CONTINUOUS PATH ROBOTS.

   (1) Arc welding
   (2) Spray painting
   (3) Flame cutting
   (4) Deburring

3. WHAT ARE THE COMMON CHARACTERISTICS OF NON-SERVO CONTROLLED ROBOTS?

   (1) Relatively high speed motion possible.
   (2) Relatively low cost, simple to operate, program and maintain.
   (3) Highly reliable.
   (4) Limited programming/positioning flexibility.

4. THE ACCURACY AND REPEATABILITY IN CONTINUOUS PATH ROBOTS DEPEND ON WHAT KINDS OF FACTORS?

   (1) Mechanisms of robots.
   (2) The resolution of the feedback devices.
   (3) Servo valve characteristics.
   (4) Controller accuracy.

5. WHAT ARE THE ADVANTAGES OF HYDRAULIC DRIVEN SYSTEMS USED IN A ROBOT?

   Hydraulic driven system gives the robot a mechanical simplicity, maintains high strength and speed, and gets more accurate control.

6. THERE ARE SEVERAL CHARACTERISTICS TO CLASSIFY THE ROBOT TECHNOLOGICAL LEVELS. WHAT ARE THEY?

   (1) Numbers of axes (degree of freedom).
   (2) Types of control systems.
   (3) Programming methods.
   (4) Types of motion.
   (5) Types of driving systems.

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Lesson Plan # 5

Course Title ROBOT SERVICE AND REPAIR Course # _____

Unit Title INTRODUCTION TO ROBOT Unit # 1

Technical Information Lesson X General /Guidance Information Lesson ___

OR

Job Skill Demonstration Lesson _____

CONFIGURATION AND END EFFECTORS

LESSON TITLE

Lesson Objective - Upon Completion of This Lesson the Student Should Be Able To:

1. VERBALLY DESCRIBE THE GEOMETRIC CONFIGURATION OF ROBOTS.
2. VERBALLY DESCRIBE THE TYPES OF END EFFECTORS.
3. VERBALLY DESCRIBE THE APPLICATION OF VACUUM CUPS, AND MAGNETIC PICK-UPS.

Tools and Materials:

Teaching Aids:

H1-5-1 SYLLABUS SHEET
T1-5-1 CUBIC (CARTESIAN) COORDINATE SYSTEM
T1-5-2 CYLINDRICAL COORDINATE SYSTEM
T1-5-3 JOINTED COORDINATE SYSTEM
T1-5-4 POLAR COORDINATE SYSTEM
T1-5-5 7 DEGREES OF FREEDOM

Informational Assignment:

INFORMATION SHEETS
IS1-5-1 GEOMETRIC CONFIGURATION OF ROBOT
IS1-5-2 END EFFECTORS

ANSWER QUESTIONS FOUND ON ASSIGNMENT SHEETS
AS1-5-1 CONFIGURATION AND END EFFECTORS

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References:

Step 1 - Introduction for Preparation of the Student:

THE MAJOR CONSIDERATION OF A ROBOT IS: IT MUST BE ABLE TO REACH WORKPIECES OR PARTS IN ITS WORKING ENVIRONMENT. USUALLY THIS REQUIREMENT WILL BE DONE BY THE COMBINATION OF AN ARM AND WRIST SUB-ASSEMBLY. THE ROBOT'S SPHERE OF INFLUENCE IS BASED UPON THE VOLUME INTO WHICH THE ROBOT'S ARM CAN DELIVER THE WRIST SUB-ASSEMBLY. BESIDES THESE, THE HAND OR CALLED END EFFECTORS ARE ALSO IMPORTANT FOR THE ROBOT TO BE USED IN DIFFERENT ENVIRONMENTS.

IN THIS UNIT, THE STUDENT WILL LEARN THE DIFFERENT KINDS OF ARM CONFIGURATIONS AND THEIR RELATED MOVING COMPONENTS WHICH HAVE TO GRASP, LIFT AND MANIPULATE WORKPIECES AND WORKING TOOLS. IN ADDITION, THE STUDENT WILL ALSO BE TAUGHT ABOUT SOME SPECIAL END EFFECTORS USED IN INDUSTRY TODAY.

Lesson Plan # 5

Course Title ROBOT SERVICE AND REPAIR Course # _____

Unit Title INTRODUCTION TO ROBOTS Unit # 1

Lesson Title: CONFIGURATION AND END EFFECTORS

STEP 2 - Presentation Outline:

I. GEOMETRIC CONFIGURATIONS OF ROBOTS
   - A. BASIC CONFIGURATIONS
   - B. CUBIC (CARTESIAN) COORDINATE SYSTEM
     T1-5-1
   - C. CYLINDRICAL COORDINATE SYSTEM
     T1-5-2
   - D. JOINT COORDINATE SYSTEM
     T1-5-3
   - E. POLAR COORDINATE SYSTEM
     T1-5-4
   - F. WRIST ASSEMBLY

II. END EFFECTORS
   - A. THE END EFFECTORS ARE:
     1. MECHANICAL GRIPPERS
     2. HOOKS
     3. VACUUM SYSTEM
     4. MAGNETIC PICK-UP
     5. TOOLS
        - a. WELDING GUNS
        - b. SPRAYERS
        - c. ROUTERS
   - B. GRIPPING FORCE
   - C. VACUUM SYSTEMS
   - D. MAGNETIC PICK-UP
   - E. TOOLS

Lesson Plan # 5

Course Title ROBOT SERVICE AND REPAIR Course # _____

Unit Title INTRODUCTION TO ROBOTS Unit # 1

STEP 3 - Classroom, Laboratory, Shop or Other Activities:

STEP 4 - Lesson Summary and Review Items to be Used to Evaluate the Lesson Against the Lesson Objective:

INTERACTIVE ITEMS:

1. HOW MANY KINDS OF MANIPULATER CONFIGURATIONS HAVE BEEN USED?

   1. Cubic coordinate
   2. Cylindrical coordinate
   3. Jointed coordinate
   4. Polar coordinate

2. WHAT ARE THE END EFFECTORS?

   An end effector is the device that performs the actual work. It is a tool or gripper which is attached to the mounting surface of the manipulater wrist which has to grasp, lift, and manipulate workpieces without causing any damage, and without letting go.

3. WHAT ARE THE ADVANTAGES OF USING VACUUM CUPS?

Some kinds of materials or parts, such as non-ferrous materials, fragile parts, plastics, etc., can not be handled by mechanical grippers or operated by magnetic pick-up methods. Then the vacuum cups are used.

4. WHAT ARE THE SURFACE CONDITIONS OF USING MAGNETIC PICK-UPS?

The surface conditions of the parts ideally should be a smooth, flat, and dry surface. Otherwise, it would affect the holding power and there would be no safety in the handling.

Lesson Plan # 5

Course Title/No. CONFIGURATION AND END EFFECTORS Course # _____

Unit Title INTRODUCTION TO ROBOTS Unit # 1

Unit Test Items **Oral, Written, or Performance:**

TRUE-FALSE

F 1. CUBIC COORDINATE SYSTEM INCLUDES TWO LINEAR AXES (X, Y) AND ONE ROTATIONAL AXIS (~~θ~~).

T 2. USUALLY, THE END EFFECTORS ARE NOT SO FLEXIBLE, THEY MAY HAVE TO BE INCLUDED ALONG WITH THE SPECIAL TOOLING REQUIREMENTS OF THE JOB.

T 3. END EFFECTORS ARE OFTEN CALLED GRIPPERS.

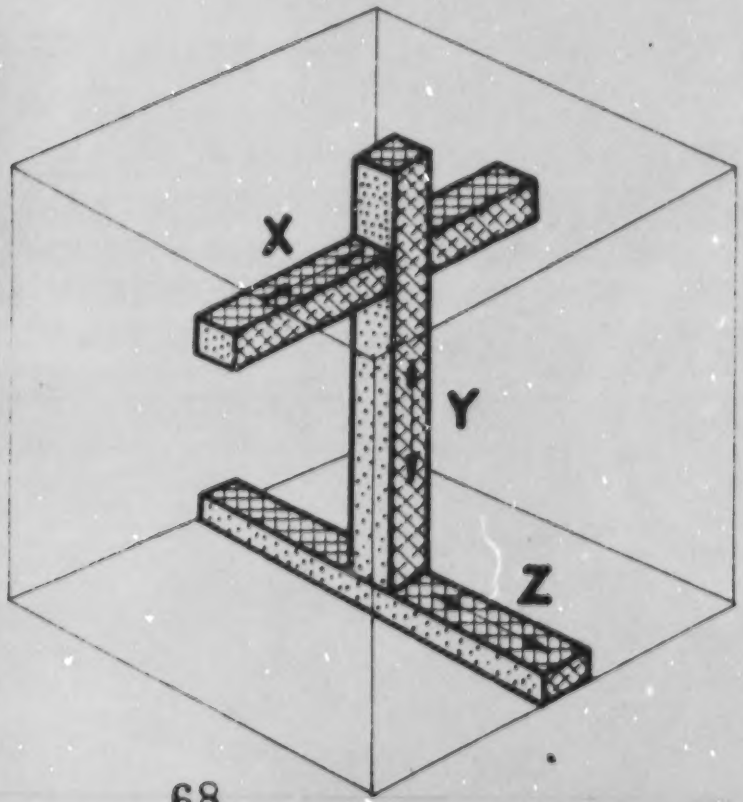
F 4. A PART TRANSFERRED BY A ROBOT IN HORIZONTAL PLAN WILL EXERT A FORCE ON THE HAND TOOLING OF THE WEIGHT OF THE PART.

F 5. WHEN THE MAGNET FACE IS IN A VERTICAL PLAN WITH ITS PARTS, THERE IS ONLY 40% OR LESS OF ITS POTENTIAL MAGNETIC FORCE.

COMPLETION

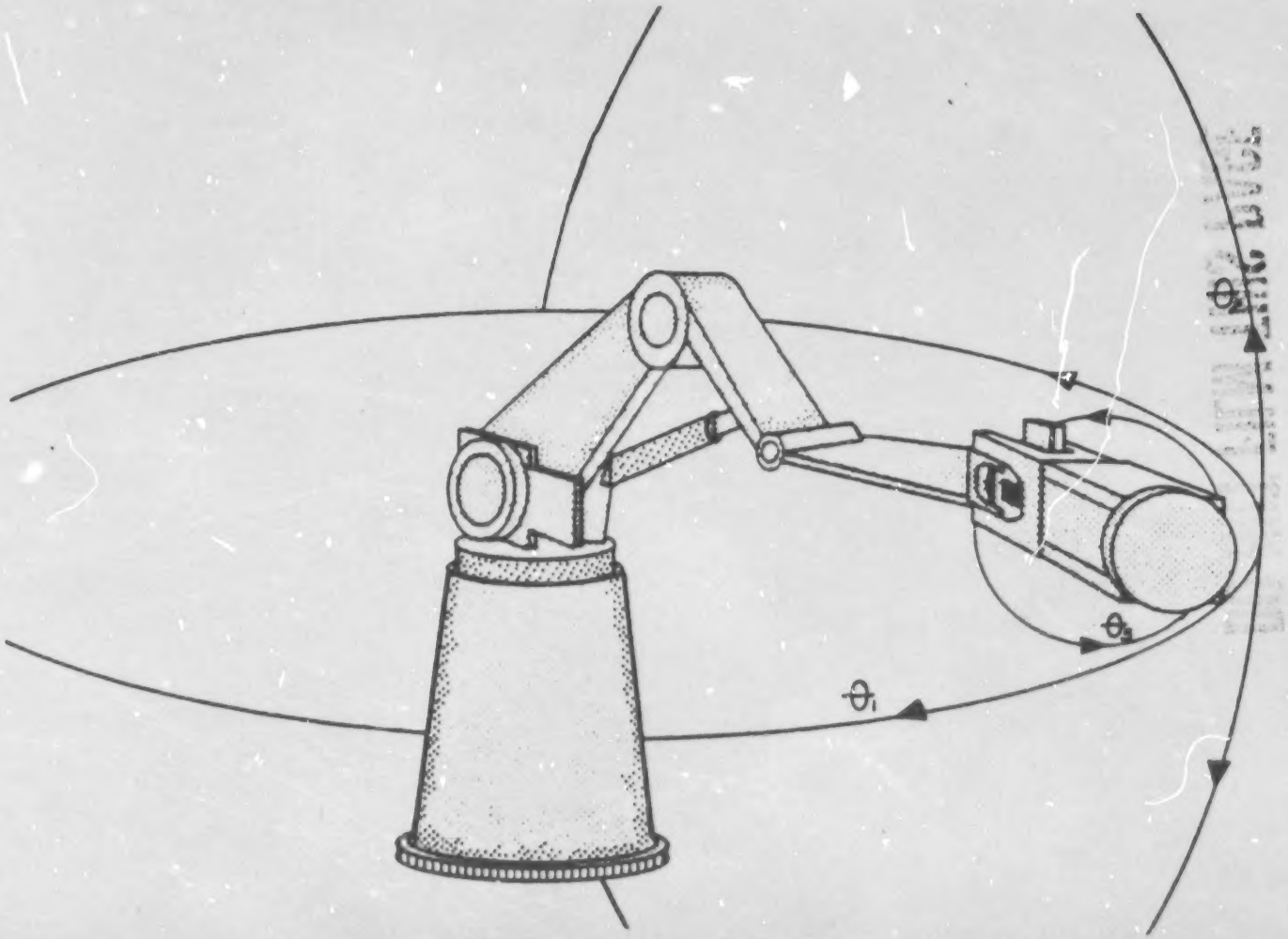
1. THE WRIST PROVIDES THREE ARTICULATIONS THAT OFFER EXTRA MOTIONS LABELED: PITCH, YAW, AND ROLL.
2. POLAR COORDINATE SYSTEM ROBOTS ARE EQUIPPED WITH A ROTARY BASE AND A PIVOT POINT WHICH CAN BE USED TO RAISE AND LOWER A TELESCOPING ARM.
3. VACUUM CUPS ARE USUALLY MADE OF AN ELASTIC MATERIAL.
4. IN ORDER TO GET THE BEST UTILIZATION OF A CUP, THE LARGEST POSSIBLE VACUUM OR PRESSURE DIFFERENTIAL SHOULD BE USED.
5. A PERMANENT MAGNET NEEDS A MEANS OF SEPARATING MATERIAL FROM THE MAGNET.
6. THE END EFFECTOR IS A DEVICE THAT PERFORMS THE ACTUAL WORK.

CARTESIAN COORDINATE SYSTEM
(X, Y, Z): 3 LINEAR AXES

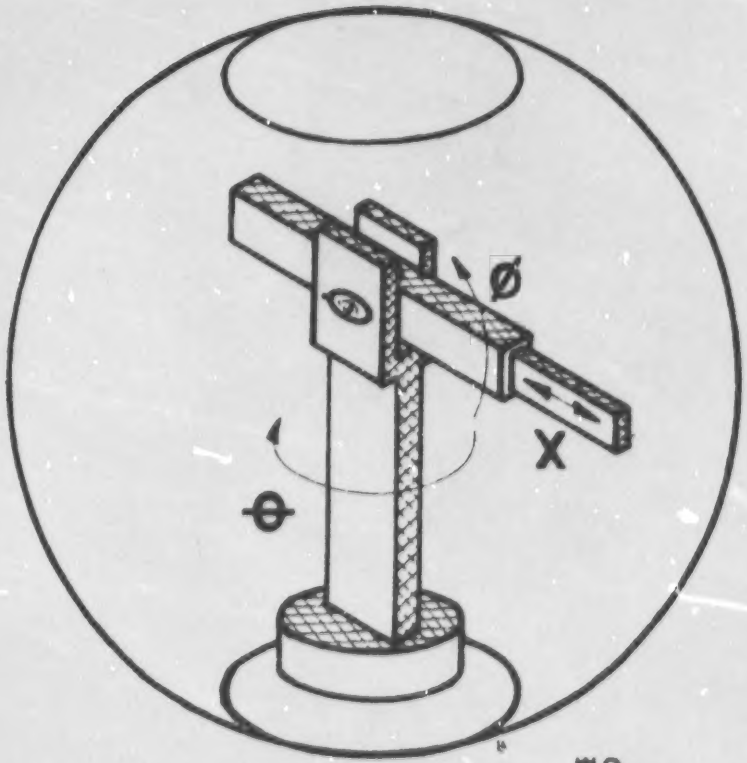


TI-5-1

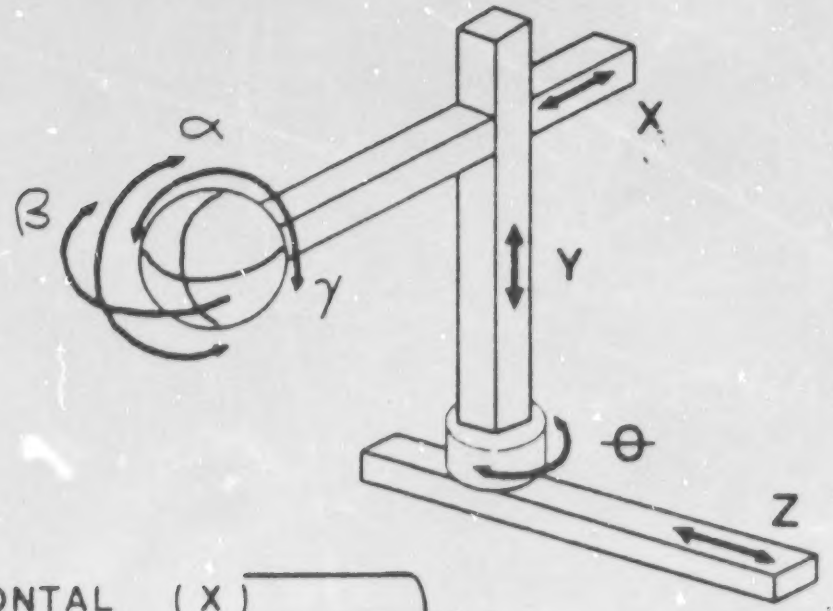
JOINTED COORDINATE SYSTEM
O_1, O_2, O_3: 3 ROTATIONAL AXES



POLAR COORDINATE SYSTEM
(X, θ, Ø): 1 LINEAR AXIS
2 ROTATIONAL AXES



7 DEGREES OF FREEDOM



1	HORIZONTAL	(X)	ARM MOTION
2	VERTICAL	(Y)	
3	SWEEP	(θ)	
4	BEND	(α)	WRIST MOTION
5	YAW	(β)	
6	ROTATE	(γ)	
7	TRAVERSE	(Z)	BODY MOTION

T1-5-5

LESSON PLAN #5

UNIT 1--CONFIGURATION AND END EFFECTORS

ASSIGNMENT SHEET 1

AFTER READING THE INFORMATION SHEET (IS1-5-1 AND IS1-5-2) PROVIDED, COMPLETE THE FOLLOWING QUESTIONS IN WRITING OR AS REQUESTED BY YOUR INSTRUCTOR.

1. WHAT ARE THE USES OF A TWO-GRIPPER HAND?

When an application needs a griper to remove a finished part and replace it with an unfinished part, a two-gripper hand is needed.

2. WHAT ARE THE FACTORS TO DETERMINE THE FORCE OF A GRIPPER TO GRASP A PART?

a. the weight of the part
b. the friction between the part and the fingers
c. how fast the robot is to move and the relation between the direction of movement to the finger's position on the part

3. IN DESIGNING A VACUUM CUP, WHAT ARE THE CRITICAL FACTORS THAT SHOULD BE CONSIDERED?

a. weight of the load
b. size of cups
c. location of the center of gravity
d. the support needed to handle large flimsy parts

4. THERE ARE SEVERAL IMPORTANT POINTS THAT MUST BE CONSIDERED BEFORE A PROPER SELECTION IN USING PERMANENT OR ELECTRO MAGNET END EFFECTORS WHAT ARE THEY?

a. shape of part
b. weight
c. temperature
d. surface condition
e. position to be handled

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Lesson Plan # 1

Course Title ROBOT SERVICE AND REPAIR Course # _____

Unit Title POWER SUPPLY Unit # 2

Technical Information Lesson X General /Guidance Information Lesson ___

OR

Job Skill Demonstration Lesson _____

HYDRAULIC POWER SYSTEM

LESSON TITLE

Lesson Objective - Upon Completion of This Lesson the Student Should Be Able To:

1. EXPLAIN THE FUNCTION OF THE BASIC COMPONENTS OF A HYDRAULIC SYSTEM.
2. USE A RELATED FORMULA TO CALCULATE THE HYDRAULIC SYSTEM DATA.
3. DESCRIBE THE OPERATION OF THE HYDRAULIC SYSTEM.

Teaching Aids:

H2-1-1 SYLLABUS SHEET
T2-1-1 BASIC HYDRAULIC SYSTEM
T2-1-2 PUMP CLASSIFICATION
T2-1-3 PUMPS
T2-1-4 PISTON PUMPS
T2-1-5 VALVES
T2-1-6 PRESSURE REDUCING VALVES
T2-1-7 CYLINDER
T2-1-8 OPERATION OF PRESSURE REDUCING VALVE
T2-1-9 FORMULA OF PUMPS
T2-1-10 FORMULA OF CYLINDERS

Informational Assignment:

IFORMATION SHEETS
IS2-1-1 INTRODUCTION
IS2-1-2 RESERVOIRS
IS2-1-3 HYDRAULIC PUMPS
IS2-1-4 VALVES
IS2-1-5 ACTUATOR-CYLINDERS
IS2-1-6 ACTUATOR-MOTORS
ANSWER QUESTIONS FOUND ON ASSIGNEMNT SHEETS
AS2-1-1 HYDRAULIC POWER SYSTEM

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Individualized Informational Assignment for Special Students:

References:

1. OSTER, JON, BASIC APPLIED FLUID POWER; HYDRAULICS, MCGRAW-HILL BOOK COMPANY, NEW YORK, 1969.
2. PEASE, D.A., BASIC FLUID POWER, PRENTICE-HALL, INC. 1969.
3. SULLIVAN, J.A., FLUID POWER-THEORY AND APPLICATION, RESTON PUBLISHING COMPANY, 1982.

Step 1 - Introduction for Preparation of the Student:

THE USE OF HYDRAULIC POWER HAS GROWN SO RAPIDLY IN THE INDUSTRIAL FIELD, ESPECIALLY IN THE INDUSTRIAL ROBOTIC AREA, WHERE HYDRAULIC POWER HAS BEEN WIDELY USED. TODAY, MOST OF THE ROBOTS HAVE DEALT CLOSELY WITH IT.

IN THIS UNIT, THE STUDENT WILL UNDERSTAND THE FUNCTIONS OF THE COMPONENTS USED IN A HYDRAULIC SYSTEM, AND A SYSTEM'S PERFORMANCES AND ITS OPERATIONS IN THE ROBOTIC APPLICATION ENVIRONMENT.

Lesson Plan # 1

Course Title ROBOT SERVICE AND REPAIR Course # _____

Unit Title POWER SUPPLY Unit # 2

Lesson Title: HYDRAULIC POWER SYSTEM

STEP 2 - Presentation Outline:

I. INTRODUCTION
   - A. TERMS AND DEFINITIONS
   - B. BASIC HYDRAULIC SYSTEM
   - C. SYMBOLS IN HYDRAULIC SYSTEMS

II. RESERVATIONS

III. HYDRAULIC PUMPS
   - A. TYPES OF PUMPS
   - B. CALCULATION FORMULA OF PUMPS

IV. VALVES
   - A. PRESSURE CONTROL VALVES
   - B. FLOW CONTROL VALVES
   - C. DIRECTIONAL CONTROL VALVES

V. ACTUATOR-CYLINDERS
   - A. CYLINDERS
   - B. THE FORCE OUTPUT OF A HYDRAULIC CYLINDER
   - C. VELOCITY OF A CYLINDER
   - D. OUTPUT POWER OF A CYLINDER
   - E. FLOW RATE OF A CYLINDER

VI. ACTUATOR-MOTORS
   - A. TYPES OF HYDRAULIC MOTORS
   - B. CALCULATIONS OF HYDRAULIC MOTORS

Lesson Plan # 1

Course Title ROBOT SERVICE AND REPAIR Course # _____

Unit Title POWER SUPPLY Unit # 2

STEP 3 - Classroom, Laboratory, Shop or Other Activities:

STEP 4 - Lesson Summary and Review Items to be Used to Evaluate the Lesson Against the Lesson Objective:

INTERACTION ITEMS:

1. IN A HYDRAULIC SYSTEM, IT BASICALLY CONTAINS FOUR COMPONENTS. WHAT ARE THEY?
   A. Reservior
   B. Hydraulic pumps
   C. Control valves
   D. Actuators

2. WHAT IS THE FUNCTION OF A RESERVOIR?
   A reservior of a hydraulic system is used to store and supply the fluid of the system.

3. NAME THE FOUR POPULAR FIXED DISPLACEMENT HYDRAULIC PUMPS.
   A. Gear pumps
   B. Vane pumps
   C. Piston pumps
   D. Screw pumps

4. WHAT ARE THE THREE IMPORTANT THINGS THAT ARE CONTROLLED IN A HYDRAULIC SYSTEM?
   A. Pressure
   B. Rate of flow
   C. Direction of fluid flow

5. WHAT IS THE SIMPLEST TYPE OF A DIRECTIONAL CONTROL VALVE?
   The simplest directional valve is the one way valve or the check valve.

6. WHAT IS THE FUNCTION OF A HYDRAULIC CYLINDER IN A HYDRAULIC SYSTEM?
   The primary function of a hydraulic cylinder is to convert fluid power into linear mechanical force and motion.

7. NAME THREE KINDS OF HYDRAULIC MOTORS.

A. Gear motor
B. Vane motor
C. Piston motor

Lesson Plan # 1

Course Title/No. ROBOT SERVICE AND REPAIR Course # _____

Unit Title POWER SUPPLY Unit # 2

Unit Test Items **Oral, Written, or Performance:**

TRUE-FALSE

T 1. A RESERVOIR IS A CONTAINER USED FOR KEEPING A SUPPLY OF WORKING FLUID IN A HYDRAULIC SYSTEM.

T 2. VANE PUMPS ARE CLASSIFIED AS FIXED OR VARIABLE DISPLACEMENT AND UNBALANCED OR BALANCED DESIGNS.

F 3. IN A FIXED DISPLACEMENT PUMP, VANES ARE INSTALLED INTO THE SLOTS IN THE ROTOR AND ARE FREE TO MOVE IN AN AXIAL DIRECTION.

F 4. THE FLOW MAY BE VARIED BY VARYING THE SPRING TENSION.

T 5. A PRIORITY FLOW DIVIDER FUNCTIONS TO SUPPLY A REGULATED FLOW TO THE PRIORITY OUTPUT, AND THE REMAINING FLOW IS ROUTED TO THE SECONDARY CIRCUIT.

T 6. A ONE WAY OF CHECK VALVE PERMITS FLOW IN ONLY ONE DIRECTION.

T 7. IF P=2000 PSI, D=400 INCHES, THEN THE SINGLE-ACTING FORCE F=25,120LBS.

F 8. AN UNBALNCED VANE MOTOR WHICH THE ROTOR IS INSTALLED IN, IS IN THE CENTER OF THE RING.

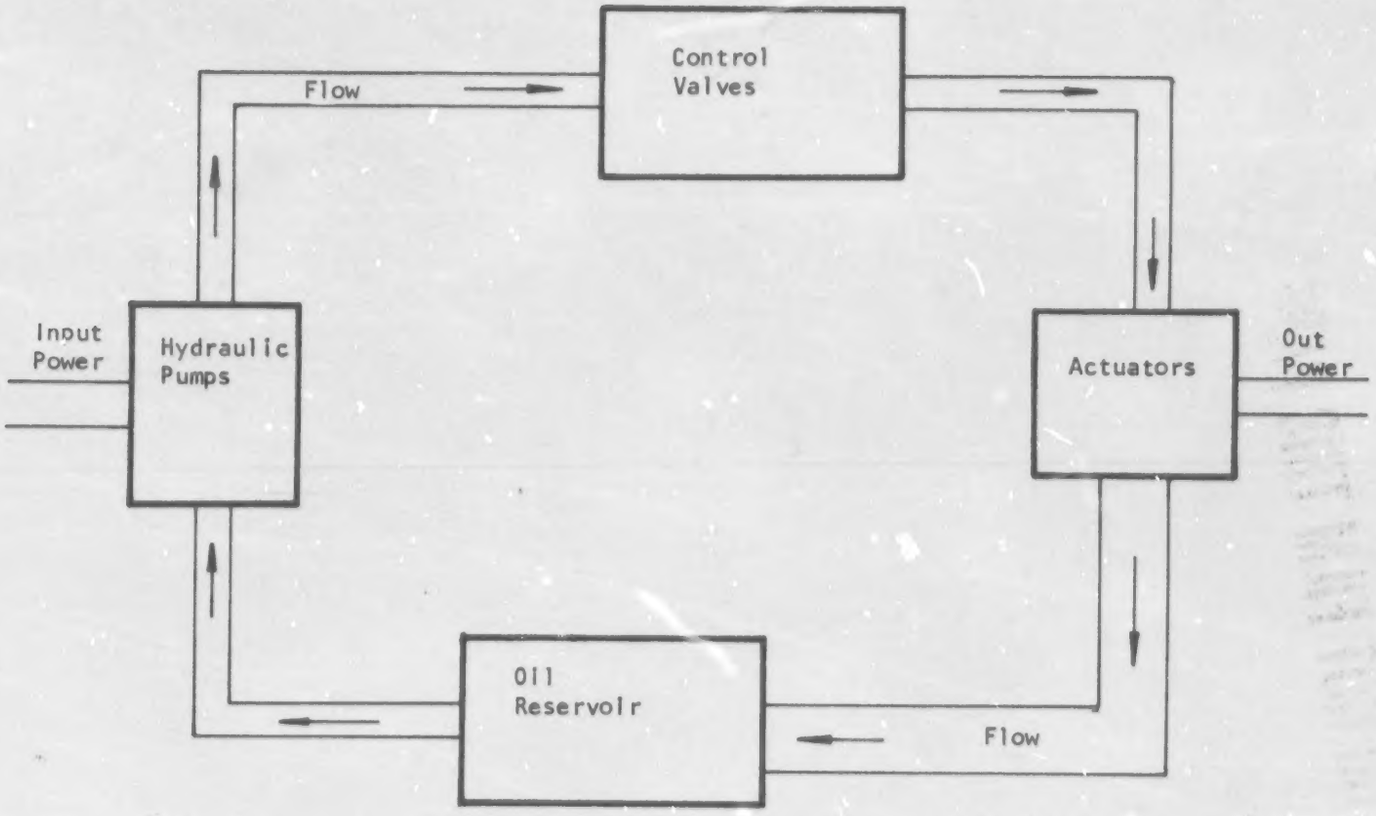
F 9. THE FLUID AT THE OUTLET OF A GEAR MOTOR IS EXPELLED AT A MUCH HIGHER PRESSURE.

T 10. EFFICIENCY= $\frac{\text{OUTPUT POWER}}{\text{INPUT POWER}}$

COMPLETION

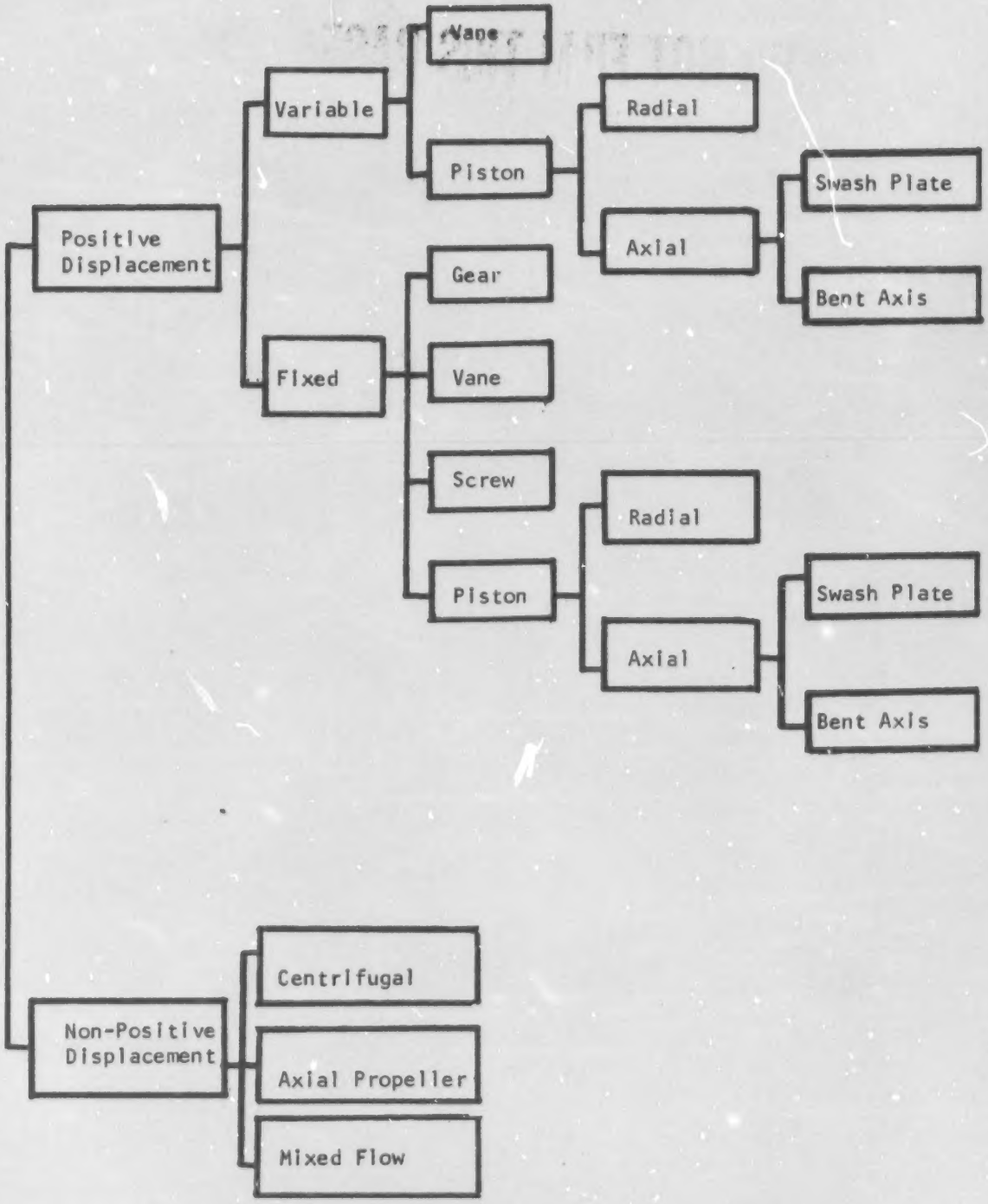
1. A HYDRAULIC SYSTEM USUALLY IS CAPABLE OF COMPLETING ONE OR SEVERAL OPERATIONS THAT CONSTITUTE A WORK CYCLE, AND IT INCLUDES THE reservoir, pump, valves, actuators AND SUITABLE PLUMBING TO TRANSFER A CIRCUIT FLUID POWER.
2. THE CAPACITY OF A RESERVOIR IS GENERALLY BETWEEN two AND three TIMES THE CAPACITY OF THE HYDRAULIC PUMP.
3. POSITIVE DISPLACEMENT PUMPS USUALLY TRANSFER A constant AMOUNT OF FLUID FOR EACH CYCLE OF OPERATION.

4. PISTONS ARE PERPENDICULAR TO THE AXIS OF THE PUMP; THIS KIND OF A PUMP IS A radial PUMP.
5. A VALVE WHOSE FUNCTION IS TO CONTROL FLOW RATE IS A flow control VALVE.
6. A pressure control VALVE IS USED TO LIMIT SYSTEM PRESSURE TO SOME PREDETERMINED LEVEL.
7. THE THREE MOST COMMON KINDS OF HYDRAULIC MOTORS ARE gear, vane, AND piston MOTORS.
8. Torque IS A MEASURE OF ROTATIONAL ROAD OR EFFORT; CALCULATED AS FORCE TIMES DISTANCE.
9. IF A MOTOR'S INLET FLOW= 21 GPM, INLET PRESSURE= 2500 PSI, THEN THE INPUT POWER OF THE MOTOR WILL BE 30.6 HP.
10. THE OPERATION OF AN IN-LINE AXIAL PISTON MOTOR IS CARRYING A SMALL AMOUNT OF FLUID FROM THE inlet TO THE outlet.

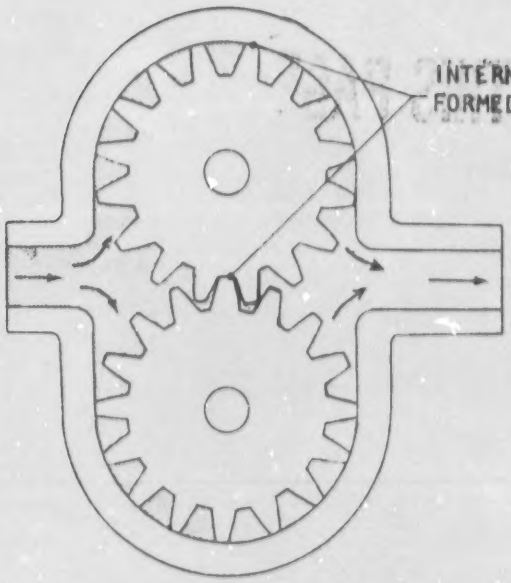


T2-6-1 BASIC HYDRAULIC SYSTEM

T2-1-1



PUMP CLASSIFICATIONS


INTERNAL SEAL
FORMED HERE

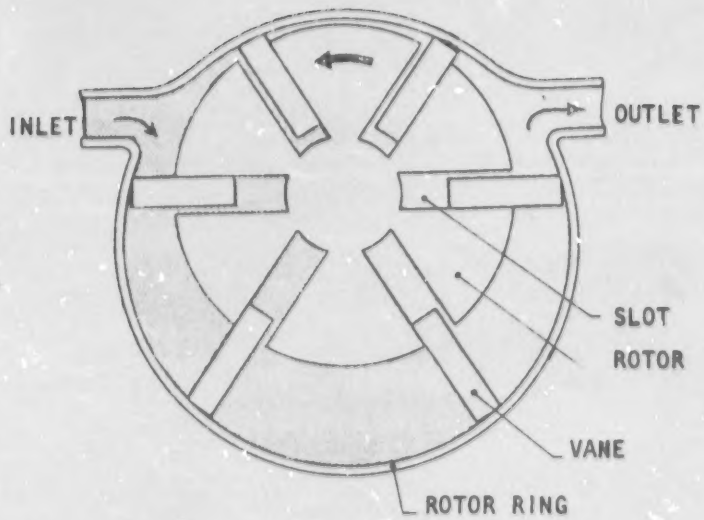

INLET
OUTLET
SLOT
ROTOR
VANE
ROTOR RING

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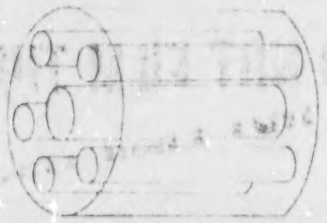
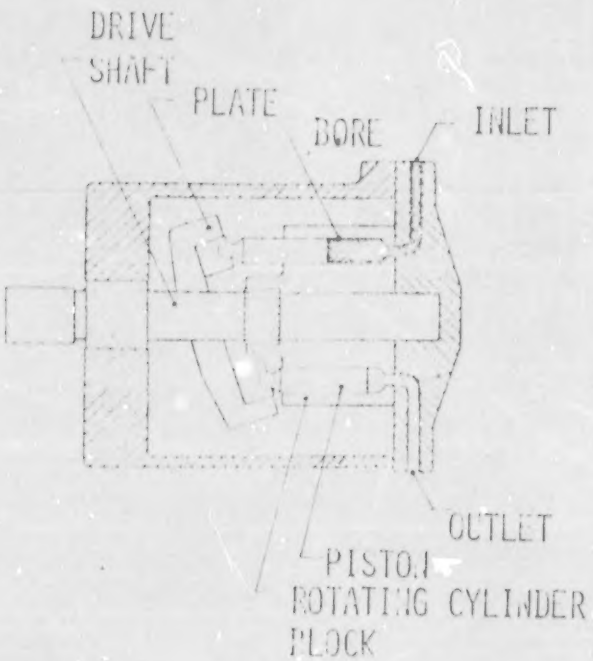
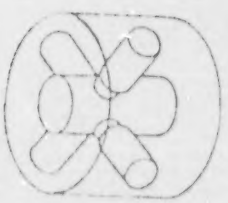
FIG. 2-6-5

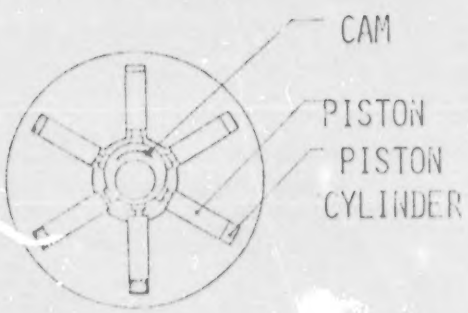


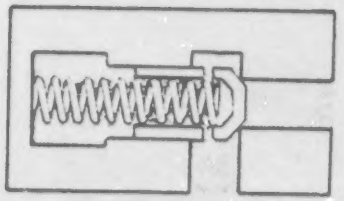
Axial Piston Pump

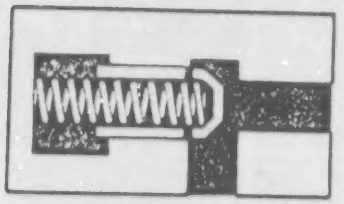


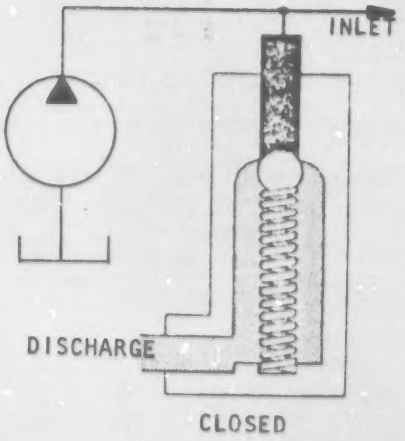


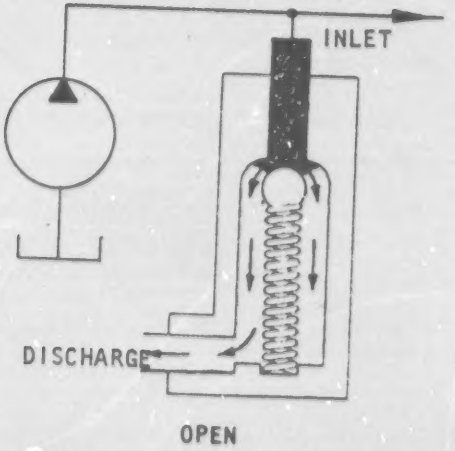
Radial Piston Pump











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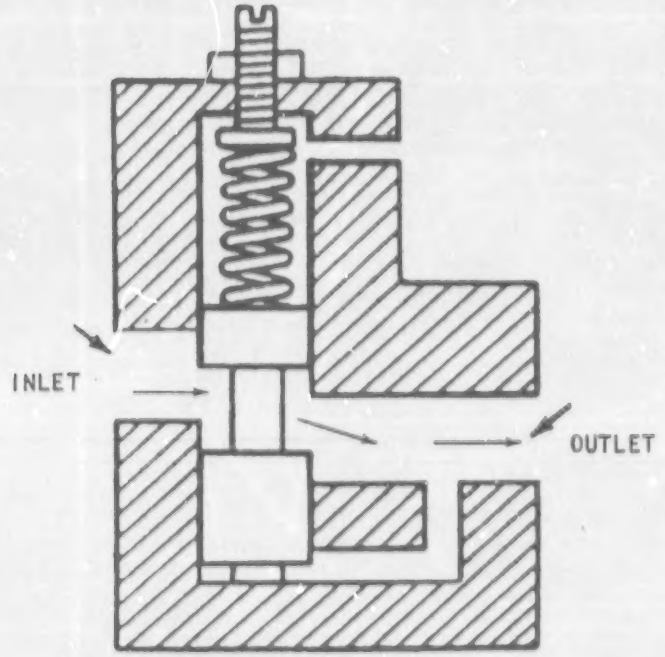
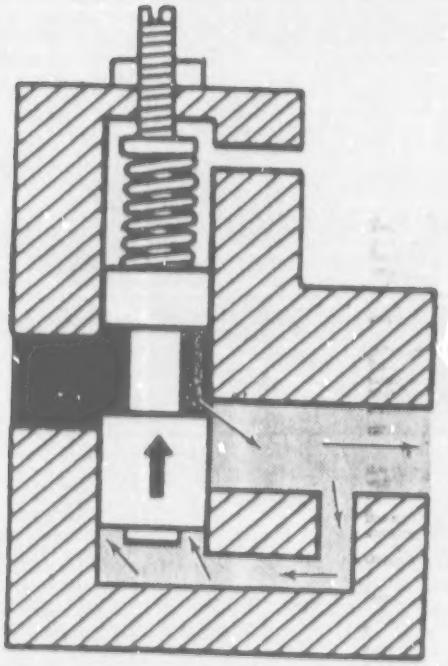
88

T2-1-5

RELIEF CONTROL VALVES

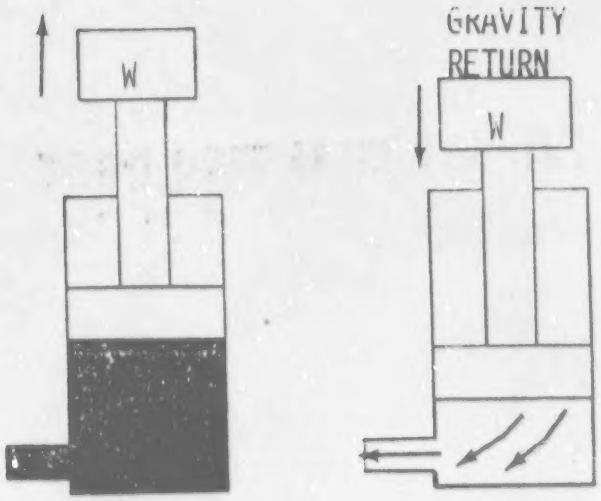


VALVE OPEN
(NOT OPERATING)

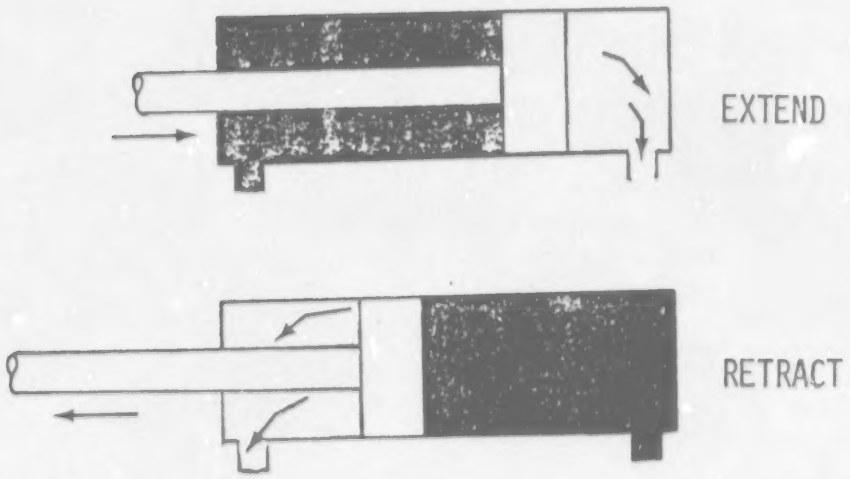


VALVE PARTLY CLOSES
(TO REDUCE PRESSURE)

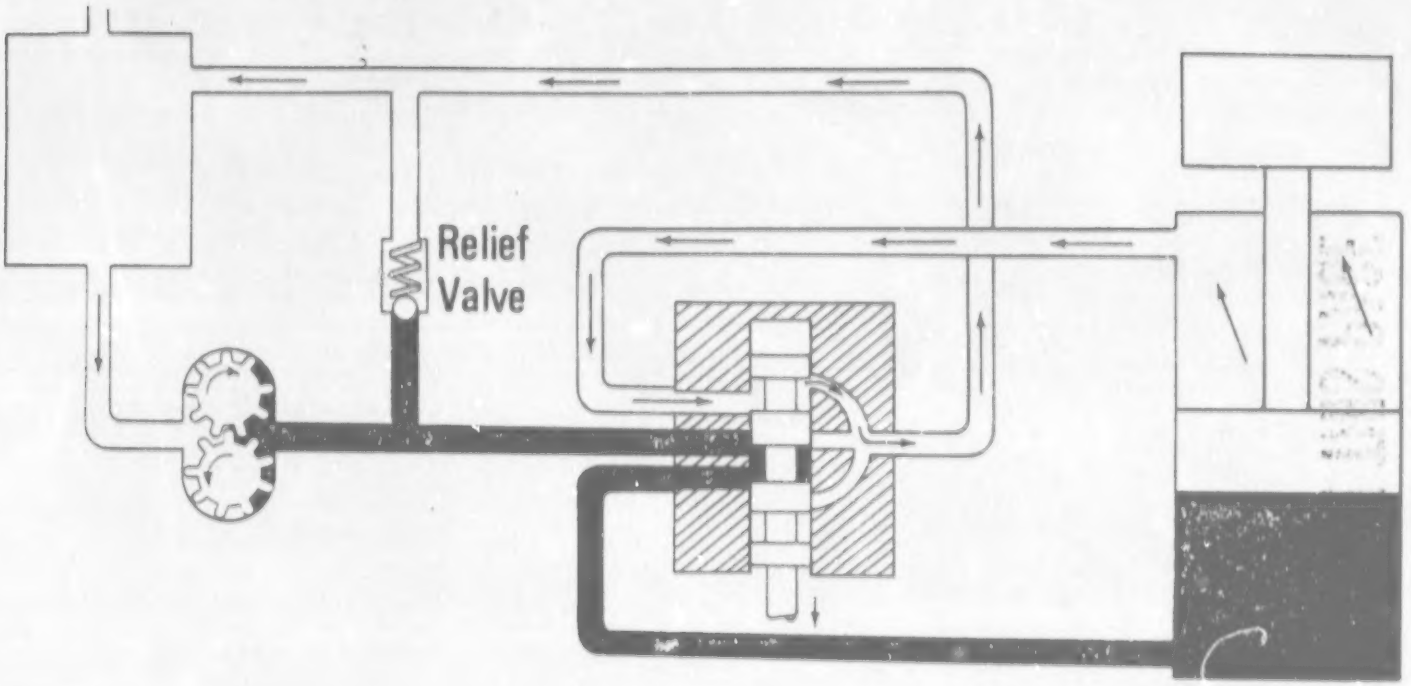
PRESSURE REDUCING VALVES



SINGLE ACTING CYLINDER



DOUBLE ACTING CYLINDER



OPERATION OF A PRESSURE RELIEF VALVE

FORMULA OF A PUMP

1. FORMULA OF PUMP DISPLACEMENT

$$D = \frac{(231) \cdot Q}{N}$$

2. FORMULA OF PUMP FLOW RATE

$$Q = \frac{D \cdot N}{231}$$

3. FORMULA OF PUMP POWER

A. OUTPUT POWER

$$\text{POWER} = \frac{P \cdot Q}{1714}$$

B. INPUT POWER

$$\text{POWER} = \frac{N \cdot \text{TORQUE}}{5252}$$

4. $$\text{VOL. EFF.} = \frac{\text{ACTUAL FLOW RATE}}{\text{THEORETICAL FLOW RATE}}$$

FORMULA OF A CYLINDER

1. THE FORCE OUTPUT OF HYDRAULIC CYLINDER
   A. SINGLE ACTING
      $F = P \times A$ (PISTON AREA)

   B. DOUBLE ACTING
      $F = P \times A - P_R \times A_R$

2. SPEED OF A CYLINDER
   A. SINGLE ACTING
      $\text{RED SPEED} = \frac{Q \cdot 19.25}{A}$

   B. DOUBLE ACTING
      $V = \frac{Q \cdot 19.25}{A}$ ------ [1. PISTON SIDE AREA; 2. ROD SIDE AREA]

3. OUTPUT POWER OF A CYLINDER
   $\text{POWER} = \frac{V \cdot F}{33{,}000}$

4. FORMULA FOR THE FLOW RATE REQUIRED TO MOVE A CYLINDER A GIVEN DISTANCE IN A GIVEN TIME.
   $Q = \frac{A \cdot L}{T \cdot 231}$

LESSON PLAN #1

HYDRAULIC POWER SYSTEM

ASSIGNMENT SHEET 1

AFTER READING THE INFORMATION SHEET (IS2-1-1, THROUGH IS2-1-6) PROVIDED, COMPLETE THE FOLLOWING QUESTIONS IN WRITING OR AS REQUESTED BY YOUR INSTRUCTOR.

1. DESCRIBE THE FUNCTIONS OF A RESERVOIR.

   A. provides fluid to replace system leakage
   B. contains excess fluid resulting from system volume changes
   C. helps to cool the system
   D. helps to separate dirt and air from fluid

2. MATCH THE TERM ON THE RIGHT WITH THE CORRECT DEFINITION.

3 A.	A DEVICE WHICH CREATES THE FLOW OF FLUID.	1. BACK PRESSURE
1 B.	PRESSURE IN THE RETURN LINE CAUSED BY FLOW THROUGH THE LINE FROM THE PUMP TO THE RESERVOIR.	2. VOLUMETRIC EFFICIENCY
2 C.	THE ACTUAL FLOW RATE FROM A PUMP DIVIDED BY THE THEORETICAL FLOW RATE.	3. PUMP
4 D.	THE VOLUME OF FLUID WHICH IS TRANSFERRED FROM THE PUMP INLET TO THE OUTLET DURING ONE REVOLUTION OF THE PUMP.	4. DISPLACEMENT

3. CALCULATE THE PUMP DISPLACEMENT FOR A PUMP WHICH HAS AN OUTLET OF 30 GPM AT 200 RPM.

   Solution: Formula $d = \frac{231\ Q}{n}$

   $d = \frac{231 \times 30}{200} = 3.465$ 9in. ^{3}/ rev.)

4. CALCULATE THE OUTPUT POWER FOR A PUMP OPERATING WITH 18 GPM FLOW AND 2700 PSI OUTLET PRESSURE.

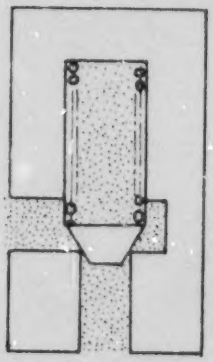
   Solution: Formula $\text{power} = \frac{P \times Q}{1714} = \frac{2700 \times 18}{1714}$

   = 28 (HP)

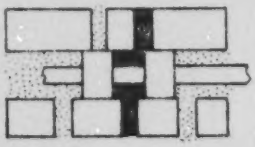
5. LIST FOUR COMMON CAUSES OF HYDRAULIC PUMP FAILURE.

A. contaminated fluid
B. improper fluid
C. improper operating procedures
D. canitation
E. improper pump maintenance

6. IDENTIFY THE TYPES OF DIRECTIONAL CONTROL VALVES.



disk valve



spool valve

7. MATCH THE TERM ON THE RIGHT WITH THE CORRECT DEFINITION.

4 A.	OIL FLOWS INTO ONLY ONE SIDE OF THE CYLINDER.	1. $\frac{TT(D-D)^2}{4}$
2 B.	PRESSURE IN THE RETURN LINES CAUSED BY FLOW IN THESE LINES.	2. BACK PRESSURE
1 C.	EFFECTIVE AREA ON THE ROD SIDE OF THE CYLINDER; EQUAL TO THE PISTON AREA MINUS THE ROD AREA.	3. CYLINDER
3 D.	AN ACTUATOR WHICH CONVERTS HYDRAULIC POWER INTO LINEAR MECHANICAL FORCE AND MOTION.	4. SINGLE-ACTING CYLINDER

8. USING THE FORMULA FOR THE FLOW RATE REQUIRED TO MOVE A CYLINDER A GIVEN DISTANCE IN A GIVEN TIME, $Q=\frac{A \times L}{T \times 231}$, CALCULATE THE FLOW RATE REQUIRED TO MOVE A 2 INCH DIAMETER CYLINDER 10 INCHES IN ONE MINUTE.

Solution: $A = \frac{TT \times (2)^2}{4} = 3.14 \text{ (in.}^2\text{)}$

$Q = \frac{3.14 \times 10}{1 \times 231} = 0.136 \text{ (GPM)}$

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Lesson Plan # 2

Course Title ROBOT SERVICE AND REPAIR Course # _____

Unit Title POWER SUPPLY Unit # 2

Technical Information Lesson X General /Guidance Information Lesson ___

OR

Job Skill Demonstration Lesson _____

ACCESSORIES OF HYDRAULIC SYSTEMS

LESSON TITLE

Lesson Objective - Upon Completion of This Lesson the Student Should Be Able To:

1. VERBALLY CLASSIFY THE TYPES OF FILTERS, LINES, FITTINGS AND SEALS USED ON A HYDRAULIC POWER SYSTEM.
2. VERBALLY DESCRIBE THE FUNCTIONS OF THOSE ACCESSORIES.

Teaching Aids:

1. H2-2-1 SYLLABUS SHEET
2. T2-2-1 TYPES OF FILTERS
3. T2-2-2 THE LOCATION OF FILTERS
4. T2-2-3 THE SIZE OF A STEEL PIPE
5. T2-2-4 HOSE TYPES AND HOSE CONSTRUCTION
6. T2-2-5 METHODS OF TUBING
7. T2-2-6 METHODS OF TUBING (CONTINUED)
8. T2-2-7 TYPES OF FITTINGS USED IN TUBING
9. T2-2-8 TYPES OF HOSE ENDS

Informational Assignment:

INFORMATION SHEETS

1. IS2-2-1 SUMMARY OF HYDRAULIC SYSTEM ACCESSORIES

ANSWER QUESTIONS FOUND ON ASSIGNMENT SHEETS

1. AS2-2-1 ACCESSORIES OF HYDRAULIC SYSTEMS

CENTER

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Department of Vocational Technical Education
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Pittsburg State University

Individualized Informational Assignment for Special Students:

References:

1. PEASE, D.A., BASIC FLUID POWER, PRENTICE-HALL, INC., N.J., 1967.
2. OSTER, JON, BASIC APPLIED FLUID POWER; HYDRAULICS, McGRAW-HILL BOOK COMPANY, N.Y., 1969.

Step 1 - Introduction for Preparation of the Student:

THE PARTS IN A HYDRAULIC SYSTEM, SUCH AS FILTERS, LINES, FITTINGS AND SEALS,ETC., ARE VERY IMPORTANT TO THE REAL ROBOTIC APPLICATIONS. IF ANY OF THESE COMPONENTS GET DEFECTED OR IMPROPERLY USED THEY WILL CAUSE A PROBLEM IN THE SYSTEM. IN THIS UNIT, THE STUDENT WILL LEARN THE FUNCTIONS AND KNOW THE CLASSIFICATIONS OF THE FILTERS, LINES, FITTINGS AND SEALS,ETC., THAT ARE USED IN A HYDRAULIC SYSTEM, FROM WHICH THE STUDENT WILL BE ABLE TO SELECT, USE AND DETECT THE PARTS FOR HYDRAULIC POWER SYSTEM APPLICATIONS.

Lesson Plan # 2

Course Title ROBOT SERVICE AND REPAIR Course # _____

Unit Title POWER SUPPLY Unit # 2

Lesson Title: ACCESSORIES OF HYDRAULIC SYSTEMS

STEP 2 - Presentation Outline:

I. FILTER
   - A. TYPES OF FILTERS (T2-2-1)
   - B. FUNCTIONS OF THE FILTERS
   - C. LOCATIONS OF FILTERS IN THE HYDRAULIC SYSTEMS (T2-2-2)
   - D. THE INFORMATION OF SELECTING THE PROPER FILTER FOR ANY APPLICATION
   - E. SYMBOL FOR A FILTER
   - F. METHODS FOR ASSURING HYDRAULIC SYSTEM CLEANLINESS

II. LINES
   - A. THE CONSIDERATION FOR SELECTING LINES FOR A HYDRAULIC SYSTEM
   - B. TYPES OF LINES (T2-2-2, T2-2-4)
   - C. TYPES OF HOSE-ENDS
   - D. FACTORS TO CONSIDER WHEN ROUTING TUBING IN A HYDRAULIC SYSTEM (T2-2-5, T2-2-6)

III. FITTING
   - A. TYPES OF FITTINGS USED WITH TUBING (T2-2-7)
   - B. TYPES OF HOSE-ENDS (T2-2-8)

IV. SEALS
   - A. TYPES OF SEALING DEVICES (T2-2-9)
   - B. TYPES OF SEAL CONSTRUCTION
   - C. FACTORS AFFECTING THE SELECTION OF SEALING DEVICES

Lesson Plan # 2

Course Title ROBOT SERVICE AND REPAIR Course # _____

Unit Title POWER SUPPLY Unit # 2

STEP 3 - Classroom, Laboratory, Shop or Other Activities:

STEP 4 - Lesson Summary and Review Items to be Used to Evaluate the Lesson Against the Lesson Objective:

INTERACTION ITEMS:

1. WHAT ARE THE FUNCTIONS OF FILTERS?
   A. To remove dirt that has entered the system through the breather.
   B. To remove metal particles generated by wear processes.
   C. To remove particles resulting from rust or corrosion of internal surfaces.

2. LIST THREE CONSIDERATIONS IN THE SELECTION OF LINES FOR A HYDRAULIC SYSTEM.
   A. The types of materials
   B. The capacity
   C. The pressure rating

3. LIST THREE FACTORS TO CONSIDER WHEN ROUTING TUBING IN A HYDRAULIC SYSTEM.

ANY THREE OF THE FOLLOWING:

A. Avoid straight-line hook-ups
B. Use the fewest and simplest bends possible
C. Support long runs of tubing
D. Avoid interference with operator controls

4. WHAT IS THE FLARED END OF THE TUBING USED FOR?

The end of the tubing is flared to mate with a fitting. 37° is most commonly used and 45° is also used in some low pressure applications.

5. WHAT IS THE GENERAL FUNCTION OF A SEAL USED FOR?

The success of applying power to any application depends largely upon the ability on the sealing devices to prevent both internal and external leakages in the system.

Lesson Plan # 2

Course Title/No. ROBOT SERVICE AND REPAIR Course # _____

Unit Title POWER SUPPLY Unit # 2

Unit Test Items Oral, Written, or Performance:

TRUE-FALSE

T 1. A SURFACE FILTER HAS A SINGLE SURFACE THAT CATCHES AND REMOVES DIRT PARTICLES LARGER THAN THE HOLES IN THE FILTER.

F 2. A PRESSURE LINE FILTER IS LOCATED AT THE INLET OF THE PUMP.

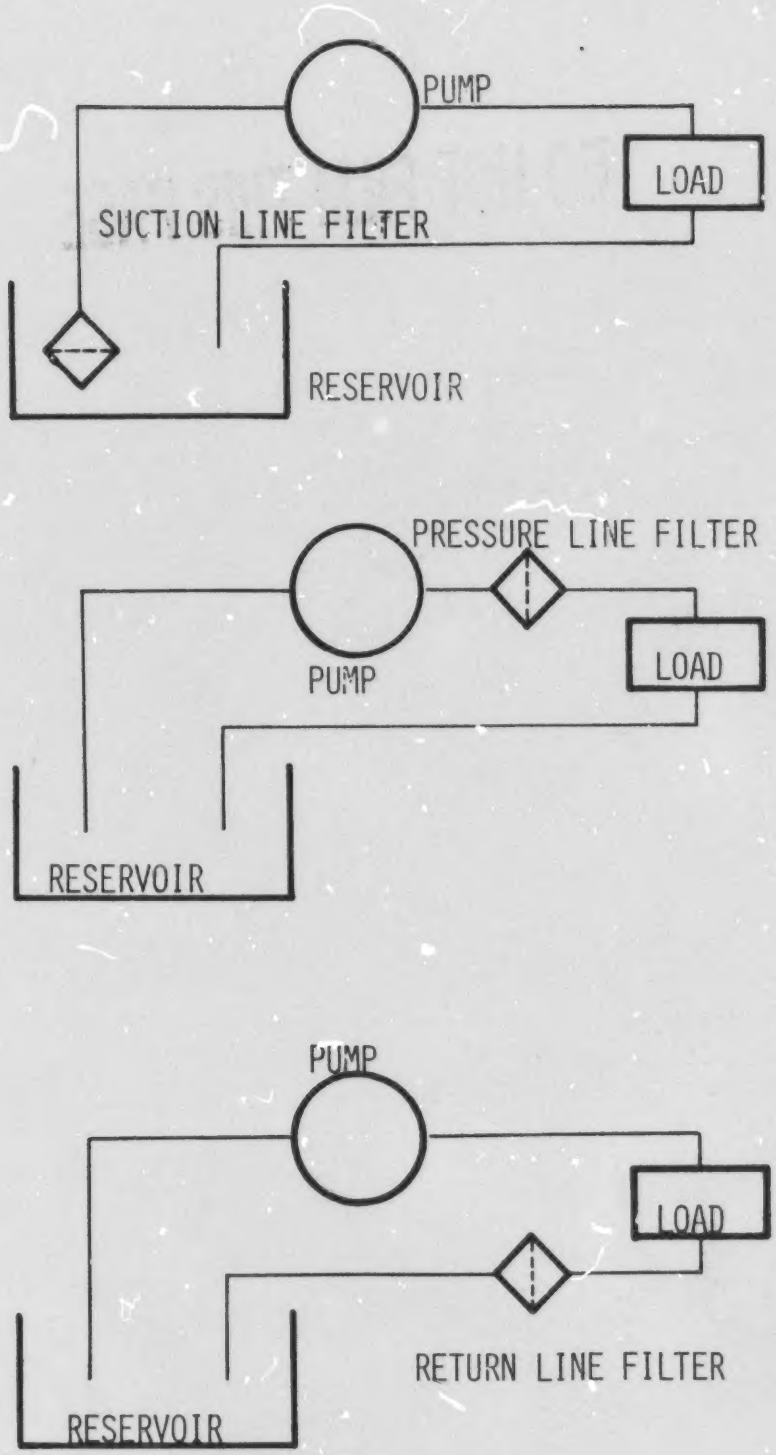
F 3. THE SIZE OF A STEEL PIPE IS SPECIFIED BY THE NOMINAL OUTSIDE DIAMETER.

T 4. AS THE CLASSIFICATION OF TUBES: THE THICKER THE WALL, THE HIGHER THE PRESSURE RANGE WILL BE.

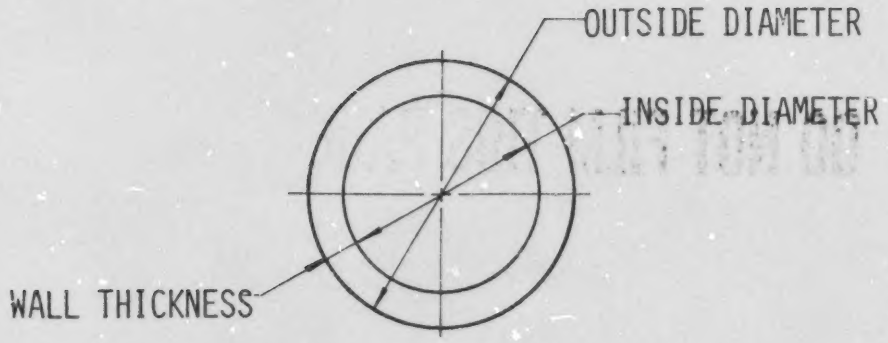
T 5. THE STANDARD HOSE TYPES WERE DEVELOPED BY THE SOCIETY OF AUTOMOTIVE ENGINEERS (SAE).

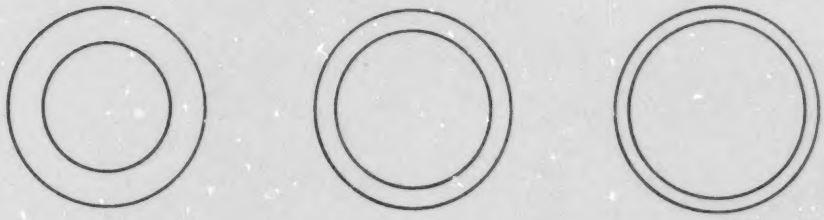
COMPLETION:

1. THE SUCTION LINE FILTER IS LOCATED AT THE inlet OF THE PUMP.
2. THE CONSIDERATIONS FOR SELECTING LINES FOR A HYDRAULIC SYSTEM ARE the types of material, capacity, AND pressure rating.
3. THE END OF THE TUBING IS USUALLY FLARED 37° DEGREES TO MATE WITH A FITTING.
4. THE REUSABLE TYPE OF HOSE-ENDS WILL ALSO BE SUBDIVIDED INTO THREE CATEGORIES. THEY ARE THE nonskive, skive, AND clamp-on.
5. THE WALL THICKNESS OF THE STEEL PIPE IS DESCRIBED BY A schedule NUMBER.



THE LOCATIONS OF FILTERS

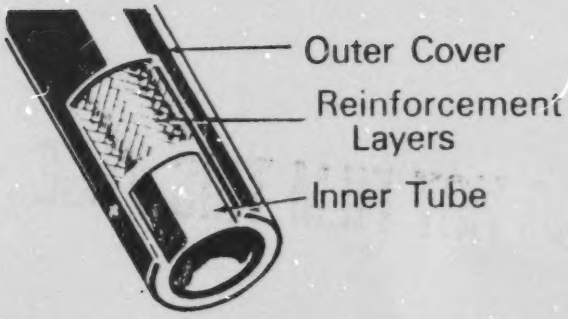




SCHEDULE 160 SCHEDULE 80 SCHEDULE 40

Nominal Size	Pipe O.D.	INSIDE DIAMETER Schedule 40	Schedule 80	Schedule 160
⅛	.405	.269	.215	
¼	.540	.364	.302	
⅜	.675	.493	.423	
½	.840	.622	.564	.466
¾	1.050	.824	.742	.587
1	1.315	1.049	.957	.815
1¼	1.660	1.380	1.278	1.160
1½	1.900	1.610	1.500	1.338
2	2.375	2.067	1.939	1.689
2½	2.875	2.469	2.323	2.125
3	3.500	3.068	2.900	2.624

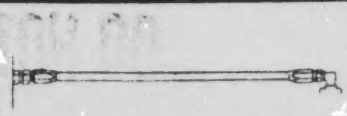
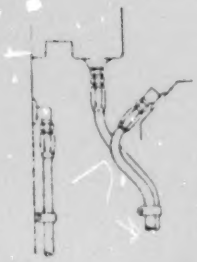
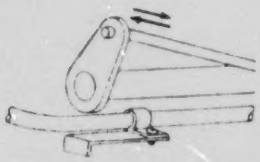
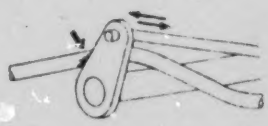
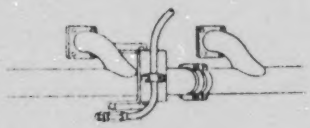
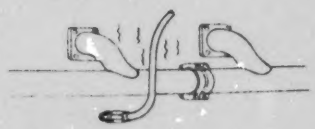
SIZE OF STEEL PIPES



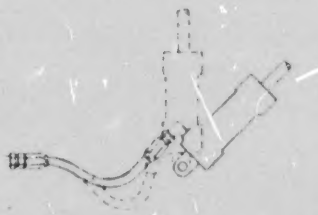
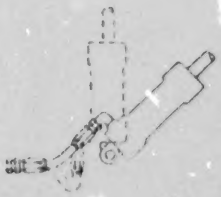
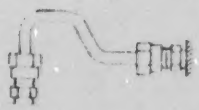
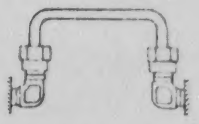
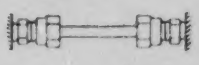
Flexible Hose Construction

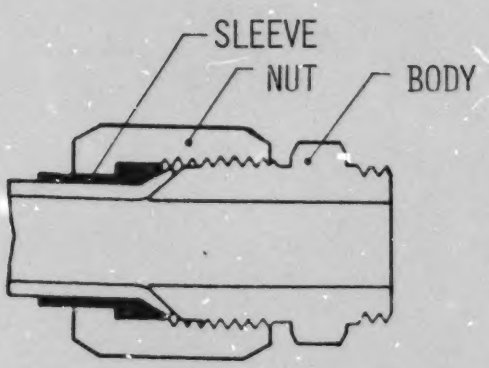
SAE Hose Types

SAE Number	Inner Tube	Reinforcement	Cover
SAE 100R1	Synthetic Rubber	1 High Tensile Steel	Synthetic Rubber
SAE 100R2	Synthetic Rubber	2 Wire Braids 2 Spiral Plies and 1 Wire Braid	Synthetic Rubber
SAE 100R3	Synthetic Rubber	2 Textile Braids	Synthetic
SAE 100R4	Synthetic Rubber	Braided Textile Fibers/ Spiral Body Wire	Synthetic
SAE 100R5	Synthetic Rubber	1 Textile Braid a High Tensile Steel Wire Braid	Cotton Braid
SAE 100R6	Synthetic Rubber	1 Textile Braid	Synthetic Rubber
SAE 100R7	Thermoplastic	Synthetic Fiber	Thermoplastic
SAE 100R8	Thermoplastic	Synthetic Fiber	Thermoplastic
SAE 100R9	Synthetic Rubber	4 Spiral Plies Wrapped In Alternating Directions	Synthetic Rubber
SAE 100R10	Synthetic Rubber	4 Spiral Plies of Heavy Wire Wrapped in Alternating Directions	
SAE 100R11	Synthetic Rubber	6 Spiral Plies of Heavy Wire Wrapped in Alternating Directions	Synthetic Rubber

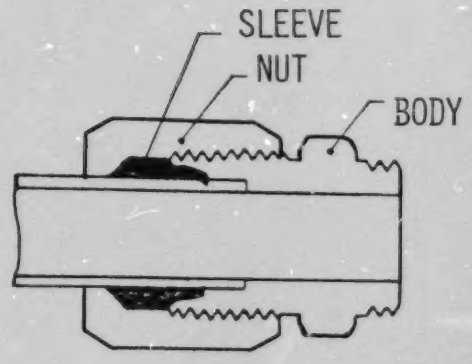
ITEMS		RIGHT	WRONG
1.	AVOID TAUT HOSE		
2.	AVOID TWISTING		
3.	AVOID LOOPS		
4.	AVOID RUBBING		
5.	AVOID HEAT		

METHODS OF TUBING

	ITEMS	RIGHT	WRONG
6.	AVOID SHARP BEND		
			
			



FLARED



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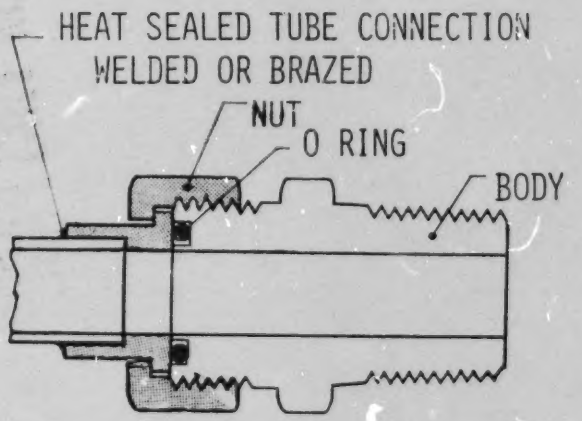
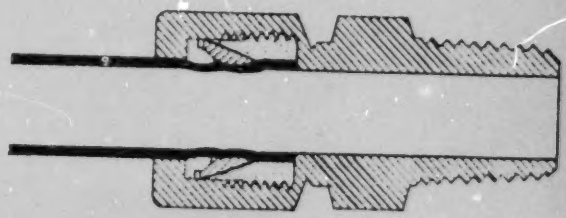
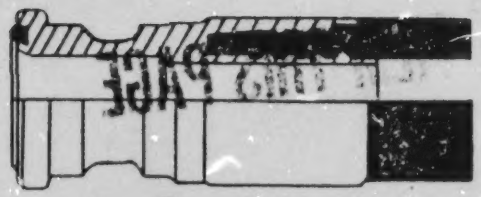


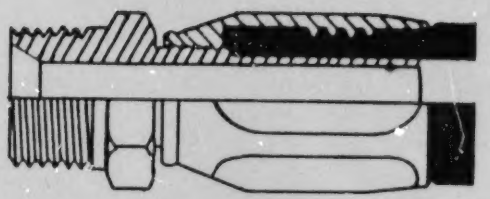
BRAZE ON



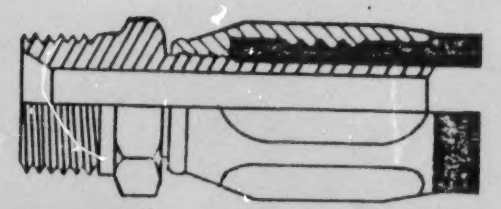
SWAGE TYPE FLARENESS



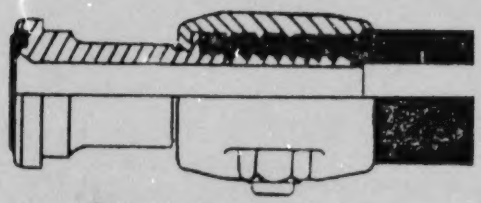
Permanent
Hose Fitting



Skive Fitting

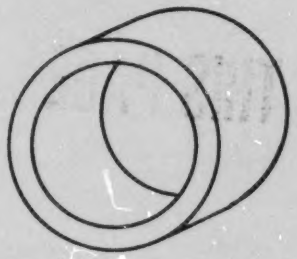
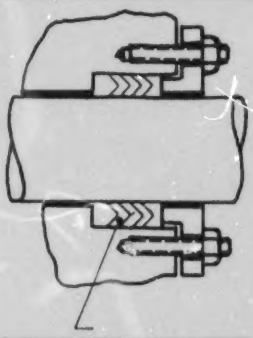
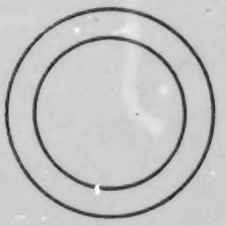
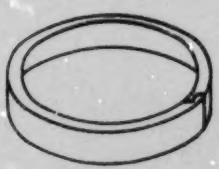
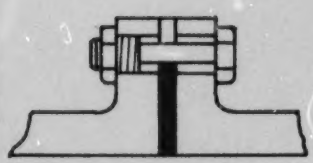


No-Skive Fitting



Clamp Type Fitting

TYPES OF HOSE-ENDS

1.	SEAL		BASIC SHAPE IS A RING. WHICH IS USED FOR KEEPING HYDRAULIC FLUID FLOWING BETWEEN CERTAIN PASSAGES.
2.	PACKING		A SEAL WHICH RESEMBLES A SPRING.
3.	O RING		A SIMPLE SEAL WITH A ROUND CROSS SECTION.
4.	BACK-UP RING		A RING INSTALLED BEHIND AN O RING OR SEAL TO HOLD IT IN PLACE.
5.	GASKET		A THIN FLAT SEAL SANWICHED BETWEEN TWO METAL SURFACES.

TYPES OF SEALING DEVICES

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LESSON PLAN #2-

ACCESSORIES OF HYDRAULIC SYSTEMS

ASSIGNMENT SHEET 1

AFTER READING THE INFORMATION SHEET (IS2-2-1) PROVIDED, COMPLETE THE FOLLOWING QUESTIONS IN WRITING OR AS REQUESTED BY YOUR INSTRUCTOR.

1. WHAT IS THE PRIMARY FUNCTION OF A SUCTION LINE FILTER?

   A suction filter is used to prevent objects, such as: nuts, bolts, and metal chips from entering the pump.

2. LIST FIVE METHODS THAT ASSURE THE HYDRAULIC SYSTEM CLEANLINESS.

   ANY FIVE METHODS OF THE FOLLOWING:

   1. Change fluid and filter regularly.
   2. Fill system only with clean oil.
   3. Clean dirt off breather caps and filter plugs prior to opening system.
   4. Use a clean, lint-free towel to wipe dipstick.
   5. Replace worn seals.
   6. Keep work area clean.
   7. Clean and flush components prior to installing system.

3. WHEN ROUTING TUBING IN HYDRAULIC SYSTEMS, WHAT KIND OF FACTORS SHOULD BE CONSIDERED?

   1. Avoid straight-line hook-ups.
   2. Support long runs of tubing.
   3. Use the fewest and simplest bends possible.
   4. Avoid interference with operator controls.

4. MATCH THE TERMS ON THE RIGHT WITH THE CORRECT DEFINITIONS.

2	A.	A SIMPLE SEAL WITH A ROUND CROSS SECTION.	1. SEALING DEVICES 2. O RING 3. GASKET 4. PACKING
4	B.	A SEAL WHICH RESEMBLES A SPRING.	
3	C.	A THIN FLAT SEAL SANDWICHED BETWEEN TWO METAL SURFACES.	
1	D.	ANY DEVICE WHICH KEEPS HYDRAULIC FLUID FROM FLOWING BETWEEN CERTAIN PASSAGES OR KEEPS FOREIGN MATERIALS FROM ENTERING THE SYSTEM.	

5. LIST FOUR CONDITIONS THAT ARE AFFECTING THE SELECTION OF SEALING DEVICES.

A. Speed and frequency.
B. Pressure.
C. Temperature.
D. Compatibility.

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Lesson Plan # _____

Course Title ROBOT SERVICE AND REPAIR Course # _____

Unit Title POWER SUPPLY Unit # 2

Technical Information Lesson ___X___ General /Guidance Information Lesson ___

OR

Job Skill Demonstration Lesson _____

DIAGNOSIS AND TESTING

LESSON TITLE

Lesson Objective - Upon Completion of This Lesson the Student Should Be Able To:

1. VERBALLY EXPLAIN THE FACTORS THAT CAUSE A HYDRAULIC SYSTEM TO HAVE PROBLEMS.
2. VERBALLY DESCRIBE THE PROBLEMS AND REMEDIES CORRECTLY.

Tools and Materials:

Teaching Aids:

H2-3-1 SYLLABUS SHEET

Informational Assignment:

IS2-3-1 DIAGNOSIS AND TESTING
ANSWER QUESTIONS FOUND ON ASSIGNMENT SHEETS

AS2-3-1 DIAGNOSIS AND TESTING

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Pittsburg State University

Individualized Informational Assignment for Special Students:

References:

1. PEASE, D.A., BASIC FLUID POWER, PRENTICE-HALL, INC., N.J., 1967.

Step 1 - Introduction for Preparation of the Student:

IN ORDER TO KEEP A SYSTEM IN A GOOD WORKING CONDITION ALL THE TIME, AN IMPORTANT THING THAT WE SHOULD KEEP IN MIND IS THAT A GOOD PREVENTIVE MAINTENANCE PROGRAM SHOULD BE ESTABLISHED. THIS KIND OF PROGRAM INCLUDES KEEPING GOOD RECORDS, CONTINUOUS INSPECTION OF EQUIPMENT, AND HEADING OFF DIFFICULTIES THROUGH SYSTEM CLEANLINESS AND MAKING MINOR REPAIRS BEFORE THEY BECOME MAJOR REPAIRS WITH COSTLY DOWN TIME. HOWEVER, IF A PROBLEM HAPPENED, WE WOULD BE ABLE TO DETECT IT AND REMEDY IT.

IN THIS UNIT THE STUDENT WILL LEARN AND KNOW WHAT PROBLEMS WILL BE HAPPENING IN A SYSTEM AND HOW TO DIAGNOSE AND TEST IT. LAST OF ALL, THE STUDENT WILL HAVE THE CAPABILITY TO KNOW HOW TO REMEDY IT.

Lesson Plan # 3

Course Title ROBOTIC SERVICE AND REPAIR Course # _____

Unit Title POWER SUPPLY Unit # 2

Lesson Title: DIAGNOSIS AND TESTING

STEP 2 - Presentation Outline:

I. THE TOOLS OF GOOD MAINTENANCE

II. PROBLEMS WHICH CAUSE AN INOPERATIVE SYSTEM AND CORRECT REMEDIES

III. PROBLEMS WHICH CAUSE A SYSTEM TO OPERATE ERRATICALLY AND CORRECT REMEDIES

IV. PROBLEMS WHICH CAUSE A SYSTEM TO OPERATE SLOWLY AND CORRECT REMEDIES

V. PROBLEMS WHICH CAUSE THE SYSTEM TO OPERATE TOO FAST AND CORRECT REMEDIES

VI. PROBLEMS WHICH CAUSE THE SYSTEM TO OVERHEAT AND CORRECT REMEDIES

VII. PROBLEMS WHICH CAUSE THE PUMP TO MAKE EXCESSIVE NOISE AND CORRECT REMEDIES

VIII. PROBLEMS WHICH CAUSE THE PUMP TO LEAK AND CORRECT REMEDIES

IX. PROBLEMS WHICH CAUSE THE POWER STEERING TO FUNCTION IMPROPERLY AND REMEDIES

X. FACTORS THAT CAUSE A SYSTEM PROBLEMS

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Lesson Plan # 3

Course Title ROBOT SERVICE AND REPAIR Course # _____

Unit Title POWER SUPPLY Unit # 2

STEP 3 - Classroom, Laboratory, Shop or Other Activities:

EXPERIMENTAL:

#1 - PERFORM GENERAL MAINTENANCE PROCEDURES ON A HYDRAULIC SYSTEM.

#2 - TEST A HYDRAULIC PUMP.

STEP 4 - Lesson Summary and Review Items to be Used to Evaluate the Lesson Against the Lesson Objective:

INTERACTION ITEMS:

1. IN ORDER TO PREVENT DELAY AND DOWN TIME IN A MAINTENANCE SCHEDULE, WHAT SHOULD WE CONSIDER?

   In order to prevent delay and down time in proceeding a hydraulic system maintenance, we should keep a good inventory of spare parts for the hydraulic system maintenance.

2. IF THE OIL LEAK IN A PRESSURE LINE SHOULD OCCUR, WHAT WILL HAPPEN AND WHAT DO YOU DO FOR IT?

   If oil leaks in a pressure line, it will cause the system to be inoperable. In this case, what we should do is tighten the fittings or replace the defective lines and examine mating surfaces on couplers for irregularities.

3. WHAT PROBLEMS WILL CAUSE THE SYSTEM TO RUN TOO FAST?

A. Adjustab'e orifice installed backward or not installed.
B. Obstruction of dirt under seat of orifice.

4. WHAT PROBLEMS CAN CAUSE THE PUMP TO LEAK?

A. Damage seal around drive shaft.
B. Loose or broken pump parts.

5. IN WHAT KIND OF SITUATIONS WILL THE CONTROL VALVE STICK OR WORK HARD?

A. Misalignment or seizing of control linkage.
B. Tie bolts too tight.
C. Valve broken or scarred internally.

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Lesson Plan # 3

Course Title/No. ROBOT SERVICE AND REPAIR Course # _____

Unit Title POWER SUPPLY Unit # 2

Unit Test Items Oral, Written, or Performance:

ANSWER THE FOLLOWING QUESTIONS:

1. LIST ONE REMEDY FOR EACH OF THE FOLLOWING PROBLEMS WHICH CAN CAUSE A SYSTEM TO OPERATE ERRATICALLY.

   A. PUMP DAMAGE - Check for broken or worn parts and determine cause of pump damage.

   B. AIR IN SYSTEM - Examine section side of system for leaks and make sure oil level is correct.

   C. COMPONENTS STICKING OR BINDING - Check for dirt or gummy deposits, and if dirt is caused by contamination, try to find the source or check for worn or bent parts.

2. IF A SYSTEM OPERATES SLOWLY, LIST 3 OF THE PROBLEMS CAUSED BY THIS.

   Any three of the following:
   A. Low oil supply.
   B. Air in system.
   C. Oil leak in the pressure lines.
   D. Valve or regulators plugged.
   E. Oil viscosity too heavy.

3. MATCH THE CORRECT REMEDIES WITH THOSE PROBLEMS WHICH MAY CAUSE THE PUMP TO MAKE EXCESSIVE NOISES.

3	A.	SLUDGE AND DIRT IN THE PUMP.	1. OPERATE PUMP AT RECOMMENDE SPEED.
5	B.	INLET SCREEN PLUGGED.	2. CLEAN OR REPLACE LINE BETW RESERVOIR AND PUMP.
2	C.	SUCTION LINE PLUGGED OR PINCHED.	3.--DISASSEMBLE AND INSPECT PU AND LINE.
1	D.	PUMP SPEED TO FAST.	--CLEAN HYDRAULIC SYSTEM.
4	E.	AIR IN FLUID.	--DETERMINE CAUSE OF DIRT.
			4.--TIGHTEN OR REPLACE SUCTION
			--CHECK SYSTEM FOR LEAK.
			--REPLACE PUMP SHAFT SEAL.
			5. CLEAN SCREEN.

4. LIST TWO PROBLEMS WHICH CAN CAUSE THE PUMP TO LEAK.

A. Damaged seal around the drive shaft.
B. Loose or broken pump parts.

5. WHAT KIND OF PROBLEMS CAUSE THE CONTROL VALVE TO STICK OR WOR HARD?

A. Misalignment or seizing of control linkage.
B. Tie bolts too tight.
C. Valve broken or scored internally.

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LESSON PLAN #3

POWER SUPPLY

ASSIGNMENT SHEET 1

AFTER READING THE INFORMATION SHEET (IS2-3-1) PROVIDED, COMPLETE THE FOLLOWING QUESTIONS IN WRITING OR AS REQUESTED BY YOUR INSTRUCTOR.

1. MATCH THE PROBLEMS WHICH MAY CAUSE AN INOPERATIVE SYSTEM ON THE RIGHT WITH THE CORRECT REMEDIES.

4	A. -FILL TO FULL MARK -CHECK SYSTEM FOR LEAKS	1. DIRT IN PUMP 2. RELIEF VALVE DEFECTIVE 3. AIR LEAK IN PUMP SUCTION LINE 4. NO OIL IN SYSTEM 5. FILTER DIRTY OR PLUGGED
1	B. -CLEAN AND REPAIR PUMP -DRAIN AND FLUSH HYDRAULIC SYSTEM, IF NECESSARY -TRY TO FIND SOURCE OF CONTAMINATION	
5	C. -DRAIN OIL AND REPLACE FILTERS -TRY TO FIND SOURCE OF CONTAMINATION	
3	D. -REPAIR OR REPLACE LINE	
2	E. -EXAMINE AND TEST VALVES, MOTORS, CYLINDERS, ETC., FOR EXTERNAL AND INTERNAL LEAKS	

2. LIST TWO PROBLEMS WHICH MAY CAUSE THE SYSTEM TO OPERATE TOO FAST.

A. Adjustable orifice installed backwards or not installed.
B. Obstruction or dirt is under the seat of the orifice.

3. WHAT KINDS OF PROBLEMS MAY CAUSE THE SYSTEM TO OVER HEAT? LIST FIVE.

A. Oil is dirty.
B. Incorrect relief valve pressure.
C. Heat is not radiating properly.
D. Restriction in pump suction line.
E. Low oil level.
F. Control valve stuck in a partially or full open position.
G. Engine is running too fast.

4. SELECT THE PROBLEMS THAT MAY CAUSE A CONTROL VALVE TO LEAK BY PLACING A "V" IN THE APPROPRIATE BLANKS.

V A. TIE BOLTS TOO LOOSE
V B. BROKEN VALVE PARTS
____ C. CRACKED RESERVOIR
V D. WORN OR DAMAGED O-RING
____ E. OIL LEVEL TOO LOW
____ F. AIR IN FLUID

5. WHAT KINDS OF PROBLEMS WILL CAUSE A CYLINDER TO LEAK?

A. Rod seal is leaking.
B. Damaged cylinder barrel.
C. Loose parts.
D. Piston rod is damaged.

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Lesson Plan # 4

Course Title ROBOT SERVICE AND REPAIR Course # _____

Unit Title POWER SUPPLY Unit # 2

Technical Information Lesson X General /Guidance Information Lesson ____

OR

Job Skill Demonstration Lesson _____

PNEUMATIC SYSTEM

LESSON TITLE

Lesson Objective - Upon Completion of This Lesson the Student Should Be Able To:

1. VERBALLY COMPARE THE PNEUMATIC SYSTEM AND THE HYDRAULIC SYSTEM.
2. VERBALLY DESCRIBE THE VARIETY OF PNEUMATIC SYSTEM COMPONENTS AND THEIR FUNCTIONS.

Tools and Materials:

Teaching Aids:

H2-4-1 SYLLABUS SHEET
T2-4-1 COMPARISON OF PNEUMATIC AND HYDRAULIC SYSTEMS
T2-4-2 BASIC PNEUMATIC SYSTEM
T2-4-3 ACTUATOR

Informational Assignment:

INFORMATION SHEETS
IS2-4-1 INTRODUCTION
IS2-4-2 PNEUMATIC SYSTEM COMPONENTS
ANSWER QUESTIONS FOUND ON ASSIGNMENT SHEETS
AS2-4-1 PNEUMATIC SYSTEM

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Individualized Informational Assignment for Special Students:

References:

1. JOHNSON, O.A., FLUID POWER-PNEUMATICS, AMERICAN TECHNICAL SOCIETY, CHICAGO, 1975.
2. PEASE, D.A., BASIC FLUID POWER, PRENTICE-HALL, INC., N.J., 1967.

Step 1 - Introduction for Preparation of the Student:

A PNEUMATIC SYSTEM IS VERY SIMILAR BOTH IN ITS CONSTRUCTION AND OPERATION TO THE HYDRAULIC SYSTEM. WHEREAS, THE HYDRAULIC SYSTEM USES A NON-COMPRESSIBLE FLUID TO TRANSMIT A FORCE BETWEEN THE SOURCE AND THE LOAD. A PNEUMATIC SYSTEM USES COMPRESSIBLE AIR TO PERFORM THE SAME FUNCTION. THEY ARE WIDELY USED IN A VARIETY OF INDUSTRIAL APPLICATIONS. TODAY, OWNING THE AIR IS CONVENIENT AND UNIVERSALLY AVAILABLE. MOST MANUFACTURING AND PROCESSING PLANTS ARE EQUIPPED TO MAINTAIN AIR FOR A VARIETY OF OPERATIONS.

IN THIS LESSON, THE STUDENT WILL LEARN AND KNOW THE BASIC PNEUMATIC SYSTEM AND ITS RELATED COMPONENTS USED IN THE SYSTEM.

Lesson Plan # 4

Course Title ROBOT SERVICE AND REPAIR Course # _____

Unit Title POWER SUPPLY Unit # 2

Lesson Title: PNEUMATIC SYSTEM

STEP 2 - Presentation Outline:

I. PNEUMATIC SYSTEM
   A. INTRODUCTION
   B. BASIC PNEUMATIC SYSTEM

II. PNEUMATIC SYSTEM COMPONENTS
   A. AIR COMPRESSORS
   B. AIR PUMPS
   C. AIR STORAGE TANKS
   D. AIR PROCESSING AND CONDITIONING UNIT
   E. CONTROL VALVES
   F. ACTUATORS

Lesson Plan # 4

Course Title ROBOT SERVICE AND REPAIR Course # _____

Unit Title PNEUMATIC SYSTEM Unit # 2

STEP 3 - Classroom, Laboratory, Shop or Other Activities:

STEP 4 - Lesson Summary and Review Items to be Used to Evaluate the Lesson Against the Lesson Objective:

INTERACTION ITEMS:

1. WHAT KIND OF DEVICE IS REQUIRED IN USING THE PNEUMATIC SYSTEM?

   Lubricating device.

2. THERE ARE TWO MAIN CATEGORIES OF COMPRESSORS. WHAT ARE THEY?

   A. Positive displacement compressors.
   B. Dynamic compressors.

3. WHAT ARE THE BASIC FUNCTIONS OF A PNEUMATIC VALVE?

   A pneumatic valve is used to regulate the pressure air velocity, flow rate and manage the direction of the air.

4. IN A PNEUMATIC SYSTEM, IF THE PRESSURE AIR CONTAINS TOO MUCH MOISTURE, WHAT SITUATION WILL HAPPEN?

A system containing too much moisture can cause oxidation of plumbing and component seizing resulting in erratic operation, failure, downtime, and costly repair.

5. WHAT IS THE PURPOSE OF USING A MUFFLER IN A PNEUMATIC SYSTEM?

The main purpose of a muffler is to reduce noise and eliminate the possibility that the air stream or airborne particles will cause unjury to personnel.

Lesson Plan # 4

Course Title/No. ROBOT SERVICE AND REPAIR Course # _____

Unit Title PNEUMATIC SYSTEM Unit # 2

Unit Test Items **Oral, Written, or Performance:**

TRUE-FALSE

F 1. THE COST OF A PNEUMATIC SYSTEM IS USUALLY HIGHER THAN A HYDRAULIC SYSTEM.

T 2. USUALLY THE AIR COMPRESSORS COMPRESS THE GASEOUS MEDIUM TO A HIGHER PRESSURE BY POSITIVELY CONFINING IT IN A GRADUALLY DECREASING SPACE.

F 3. DIRECTIONAL CONTROL VALVES ARE USED AS AIR LINE REGULATORS.

F 4. THE AIR FILTERS ARE LOCATED IN THE COMPRESSOR OUTLET IN THE PRESSURE LINE BEFORE COMPONENTS AND IMMEDIATELY PROCEEDING POWER TOOLS.

T 5. THE AIR USED IN A SYSTEM CONTAINING EXCESSIVE MOISTURE CAN CAUSE OXIDATION OF PLUMBING AND COMPONENT SEIZING, RESULTING IN ERRATIC OPERATION FAILURE, DOWNTIME AND COSTLY REPAIR.

T 6. LUBRICATORS ARE USED TO ASSURE PROPER LUBRICATION OF INTEGRAL MOVING PARTS OF PNEUMATIC COMPONENTS.

COMPLETION

1. AN AIR COMPRESSOR IS LIKE A PUMP. IT IS INTENDED TO SUPPLY CLEAN, DRY AIR TO THE WORK STATION.
2. PNEUMATIC SYSTEMS USE GASEOUS FOR THEIR CONTROL MEDIUM.
3. MANY COMPONENTS OF PNEUMATIC SYSTEMS HAVE THE SAME NAME AND PERFORM THE SAME TASK AS THEY DID IN THE HYDRAULIC SYSTEM.
4. A HYDRAULIC SYSTEM USES A NON-COMPRESSIBLE FLUID TO TRANSMIT A FORCE, HOWEVER A PNEUMATIC SYSTEM USES COMPRESSIBLE AIR TO PERFORM THE SAME FUNCTION.
5. A STORAGE TANK ACTS AS A RESERVOIR FOR THE COMPRESSED AIR.
6. A PRESSURE CONTROL VALVE IS USUALLY CALLED AN AIR LINE REGULATOR.

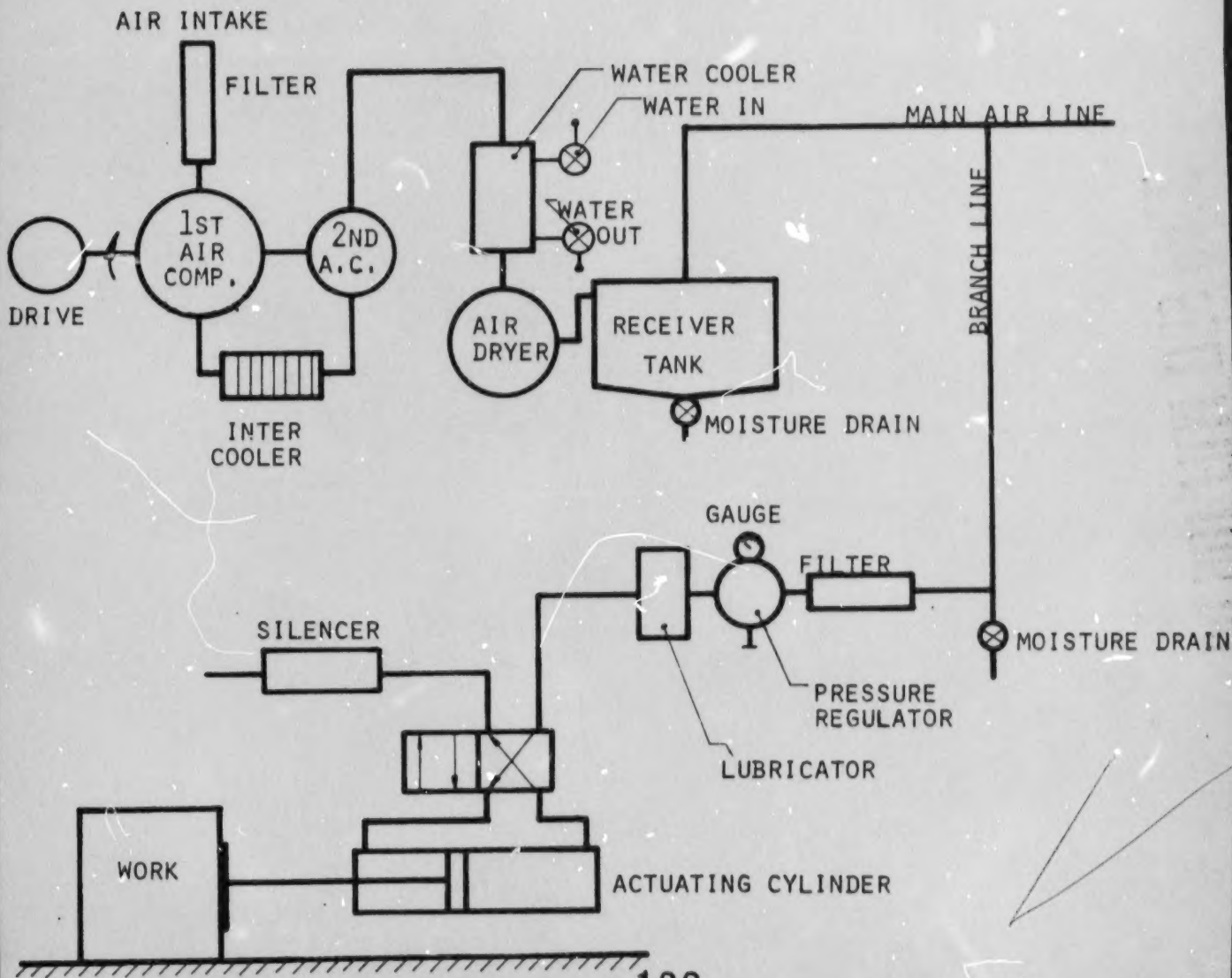
7. THE AIR CONDITIONING UNIT CONSISTS OF FILTERS, MOISTURE SEPARATORS, AIR DRIERS, LUBRICATORS, AND MUFFLERS.

8. MUFFLERS, ARE CALLED SILENCERS WHICH ARE USED TO REDUCE NOISE IN A SYSTEM.

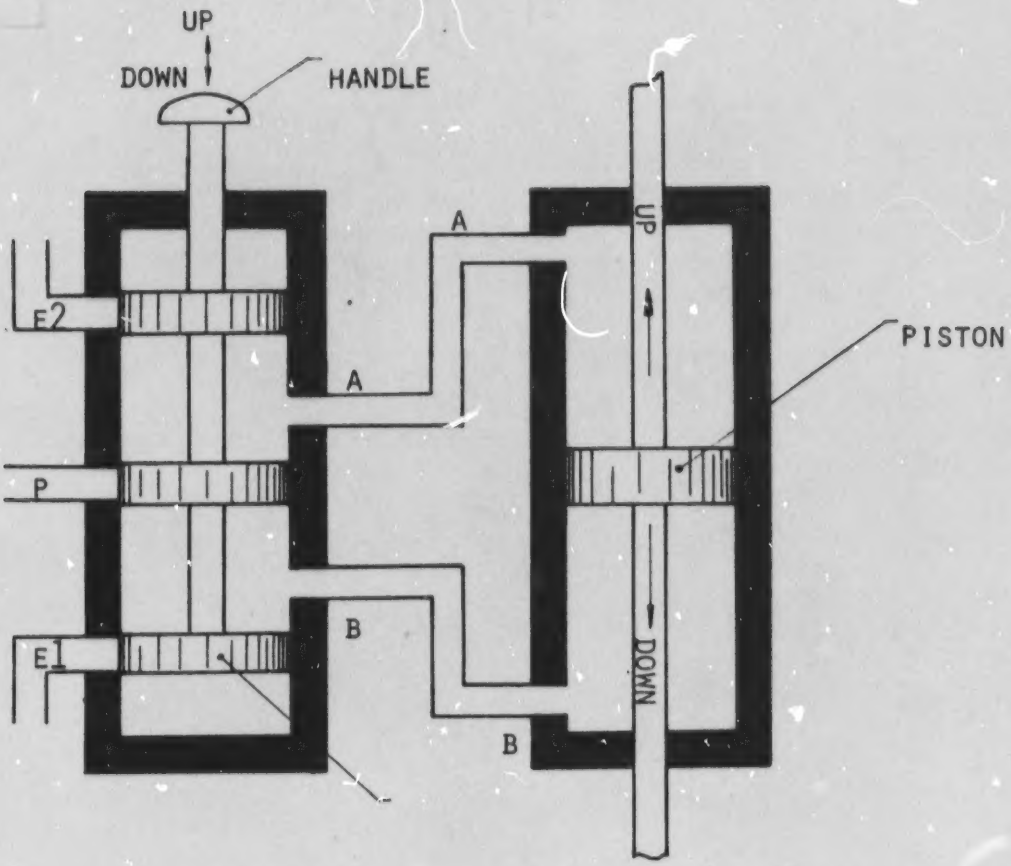
COMPARISON OF PNEUMATIC AND HYDRAULIC SYSTEMS

ITEMS	PNEUMATIC	HYDRAULIC
RELIABILITY	VERY GOOD	VERY GOOD
POSITIONING ACCURACY	VERY GOOD	VERY GOOD
LOAD	LIGHT	HEAVY
COST	LESS EXPENSIVE	MORE EXPENSIVE
MEDIA	GASEOUS	LIQUID
EQUIPMENT REQUIRED	LUBRICATING DEVICES	LUBRICATION IS NO PROBLEM
WORKING PART	LARGER	SMALLER

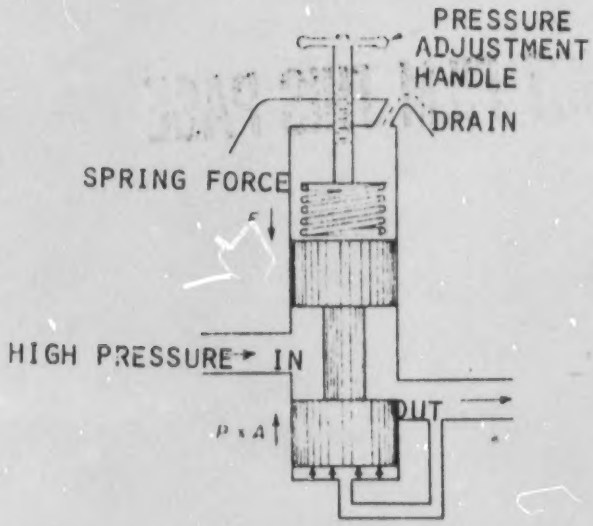
BASIC PNEUMATIC SYSTEM



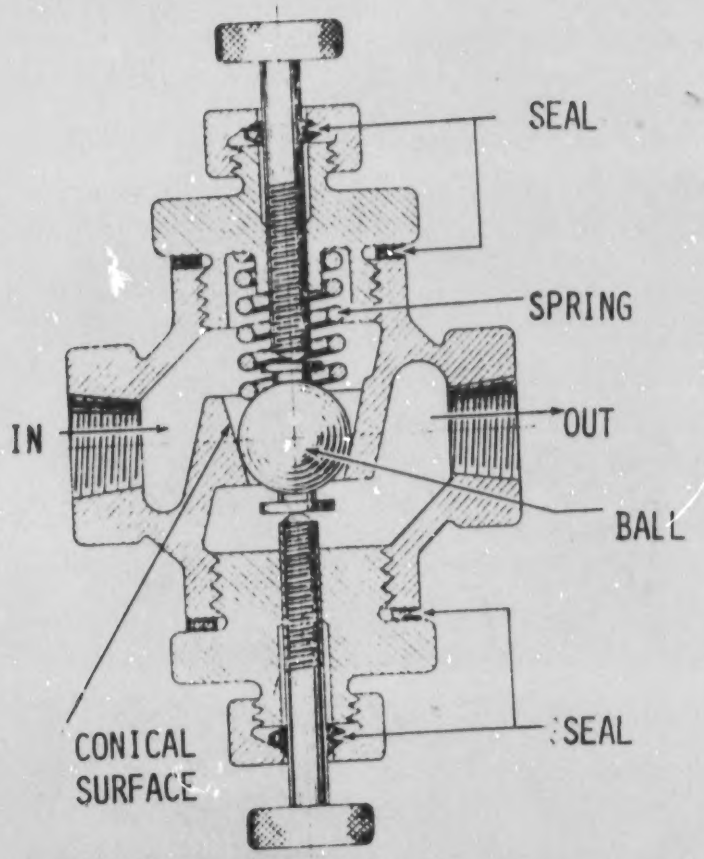
4-WAY CONTROL VALVE DOUBLE ACTING ACTUATOR



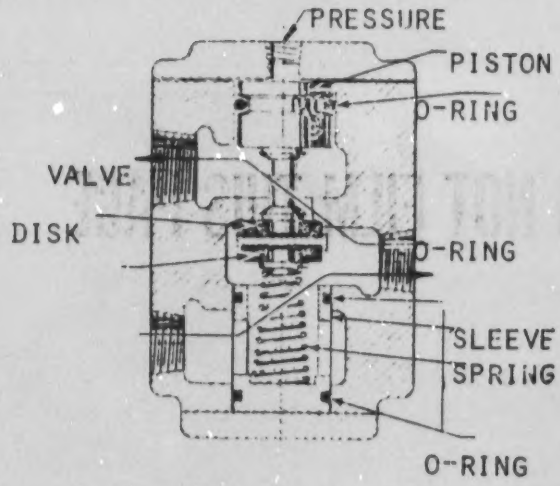
PRESSURE REGULATOR



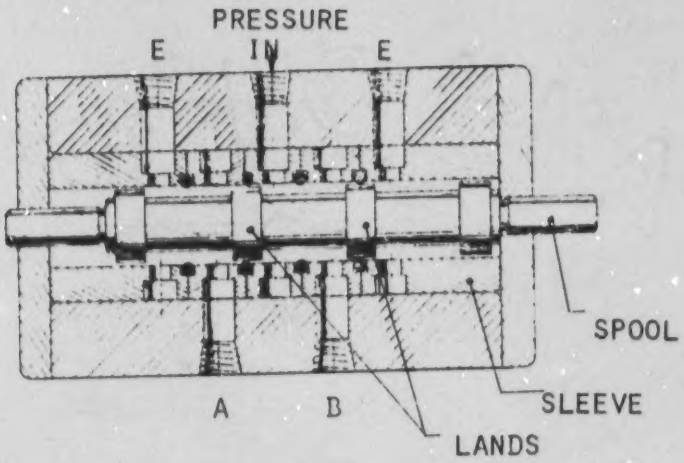
2-WAY CONTROL VALVE



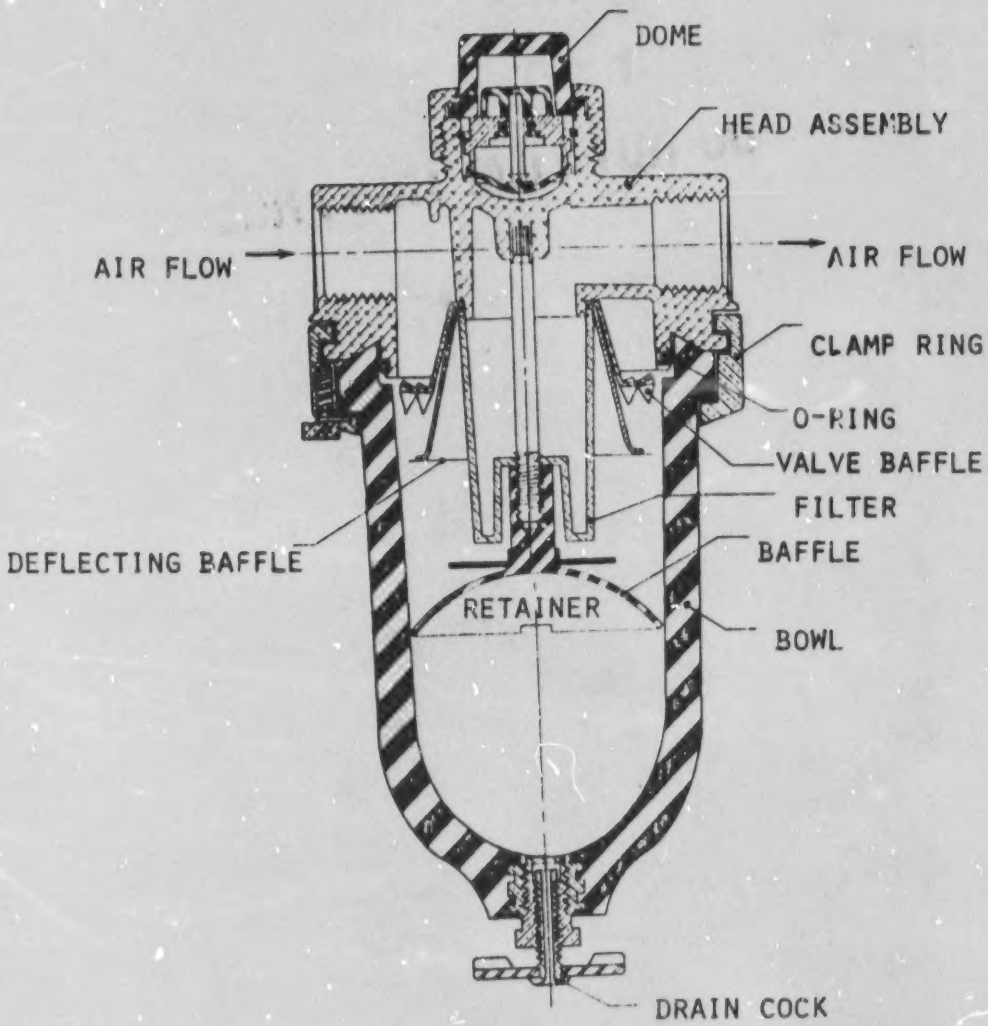
3-WAY VALVE



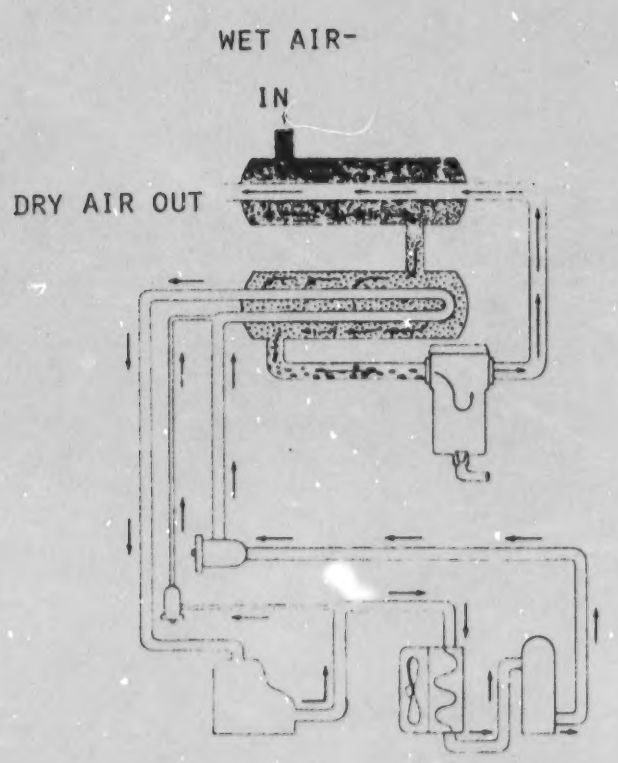
4-WAY VALVE



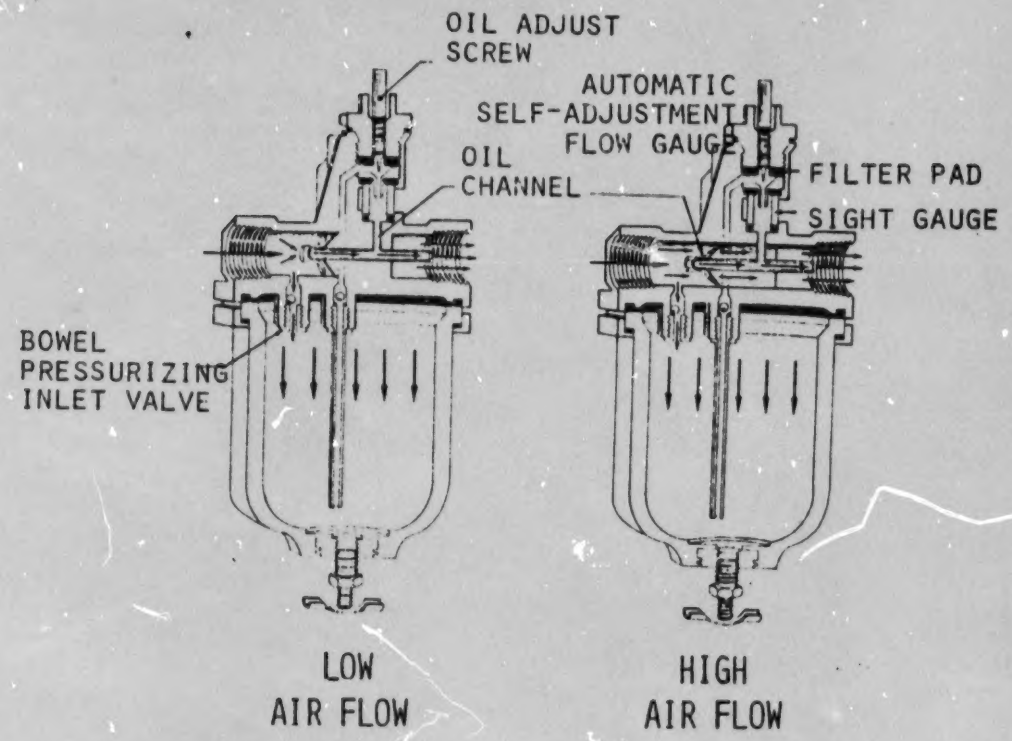
AIR FILTER


DOME
HEAD ASSEMBLY
AIR FLOW
AIR FLOW
CLAMP RING
O-RING
VALVE BAFFLE
FILTER
BAFFLE
DEFLECTING BAFFLE
RETAINER
BOWL
DRAIN COCK

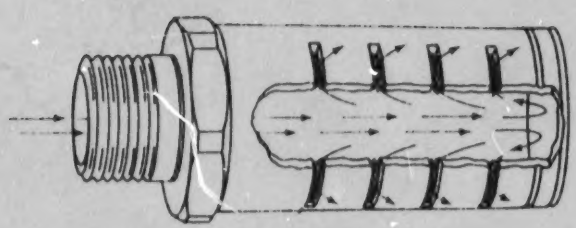
REFRIGERATED DRYER CYCLE



LUBRICATORS



MUFFLER



LESSON PLAN #4

UNIT 2 - POWER SUPPLY

ASSIGNMENT SHEET 1

AFTER READING THE INFORMATION SHEETS (IS2-4-1 AND IS2-4-2) PROVIDED, COMPLETE THE FOLLOWING QUESTIONS IN WRITING OR AS REQUESTED BY YOUR INSTRUCTOR.

1. WHAT ARE THE FUNCTIONS OF THE AIR COMPRESSORS?

Air compressors are pumps. They are intended to supply clean, dry air to the work station.

2. WHAT IS THE RELIEF VALVE USED FOR?

A relief valve is attached to the pressurized tanks so that the relief valve can be inspected with gas in the tank for the safety purpose.

3. WHAT ARE THE FUNCTIONS OF THE AIR CONDITIONING UNIT?

The airconditioning unit takes the compressed air from the tank and removes any dirt and moisture contained in the air.

4. MATCH.

4	A.	A CONTROL VALVE AND AN ACTUATOR ALWAYS WORK HAND IN HAND TO POSITION A LOAD.	1. FILTER 2. LOAD 3. DIRECTIONAL VALVE 4. ACTUATORS 5. AIR COMPRESSURES
1	B.	A COMPONENT LOCATED IN THE COMPRESSOR INTAKE IN THE PRESSURE LINE.	
3	C.	A COMPONENT USED TO STOP, START, DIVERT, SHUTTLE, AND MANAGE THE DIRECTION OF THE FLUID (AIR) IN A SYSTEM.	
5	D.	PUMPS.	
2	E.	PNEUMATIC SYSTEM IS LIGHTER THAN HYDRAULIC SYSTEMS IN WHAT?	

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Lesson Plan # 5

Course Title ROBOT SERVICE AND REPAIR Course # _____

Unit Title POWER SUPPLY Unit # 2

Technical Information Lesson X General /Guidance Information Lesson ____

OR

Job Skill Demonstration Lesson _____

ALTERNATING CURRENT POWER

LESSON TITLE

Lesson Objective - Upon Completion of This Lesson the Student Should Be Able To:

1. VERBALLY EXPLAIN HOW AN ALTERNATING - CURRENT GENERATOR WORKS.
2. VERBALLY DESCRIBE THE CONNECTION OF AN ALTERNATING CURRENT.
3. VERBALLY DESCRIBE THE PRINCIPLE OF AN A.C. MOTOR.
4. LIST THE TYPES OF A.C. MOTORS AND TELL THEIR DIFFERENCES.

Tools and Materials:

2-5-H1 SYLLABUS SHEET
T2-5-1 FREQUENCY OF AN ALTERNATING CURRENT
T2-5-2 WYE CONNECTION IN ACTUAL APPLICATION
T2-5-3 A THREE PHASE WYE CONNECTED TO AN ALTERNATING CURRENT
T2-5-4 A DELTA CONNECTION
T2-5-5 A THREE PHASE DELTA CONNECTED TO AN ALTERNATING CURRENT GENERATOR
T2-5-6 THE DIFFERENCE BETWEEN A DELTA AND A WYE CONFIGURATED GENERATOR

Informational Assignment:

IS2-5-1 ALTERNATING CURRENT GENERATOR
IS2-5-2 ALTERNATING CURRENT MOTOR
ANSWER QUESTIONS FOUND ON ASSIGNMENT SHEETS
AS2-5-1 ALTERNATING CURRENT POWER

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Individualized Informational Assignment for Special Students:

References:

1. BEAUCHAMP, W.L. AND MAYFIELD, J.C., BASIC ELECTRICITY, SCOTT, FORESMAN AND COMPANY, 1943.
2. SELLY, SAMUEL AND POULARIKAS, A.D., ELECTRICAL ENGINEERING, MATRIX PUBLISHERS, INC., OREGON, 1982.
3. MILLERMASTER, R.A., HARWOOD'S CONTROL OF ELECTRIC MOTORS, WILEY INTERSCIENCE, N.Y., 1970.

Step 1 - Introduction for Preparation of the Student:

MOST ELECTRIC POWER UTILIZED BY HOME, FARM, OR INDUSTRY IS GENERATED BY ALTERNATING CURRENT GENERATORS. THEY ARE ALSO WIDELY USED IN AIRCRAFTS AND AUTOMOBILES. ALTERNATING CURRENT GENERATORS ARE MADE IN MANY DIFFERENT SIZES DEPENDING ON THEIR INTENDED USE.

IN THIS UNIT, THE STUDENT WILL LEARN AND KNOW THE ALTERNATING CURRENT GENERATORS, A.C. MOTORS AND THEIR FUNCTIONS. THE STUDENTS WILL ALSO BE ABLE TO DESCRIBE THEIR PRINCIPLES, FUNCTIONS AND APPLICATIONS.

Lesson Plan # 5

Course Title ROBOT SERVICE AND REPAIR Course # _____

Unit Title POWER SUPPLY Unit # 2

Lesson Title: ALTERNATING CURRENT POWER

STEP 2 - Presentation Outline:

I. A.C. GENERATOR
- A. CONSTRUCTION
- B. PRINCIPLE
- C. OPERATIONS
- D. PHASE OF AN ALTERNATING CURRENT
- E. FREQUENCY OF AN ALTERNATING CURRENT (T2-5-1)

  FORMULA: $F = \frac{SP}{60}$

  WHERE: F = FREQUENCY, HZ.
  S = SPEED OF GENERATOR, R.P.M.
  P = NUMBER OF PAIRS-OF-POLES
  60 = CONVERSION FACTOR (F IN HZ AND S IN RPM)
- F. CONNECTION OF AN ALTERNATING CURRENT
  1. THE WYE CONNECTION (T2-5-2, T2-5-3)
  2. THE DELTA CONNECTION (T2-5-4, T2-5-5)
- G. THE MAJOR DIFFERENCE BETWEEN A DELTA AND A WYE CONFIGURATED GENERATOR, (T2-5-6)
- H. SINGLE AND THREE PHASE VOLTAGE OUTPUTS

II. AC MOTOR
- A. INTRODUCTION
- B. CURRENT-CARRYING CONDUCTOR IN A MAGNETIC FIELD
- C. INDUCTION MOTOR
- D. SYNCHRONOUS MOTOR
- E. SIMPLE PHASE MOTORS
- F. CARE OF MOTORS

Lesson Plan # 5

Course Title ROBOT SERVICE AND REPAIR Course # _____

Unit Title POWER SUPPLY Unit # 2

STEP 3 - Classroom, Laboratory, Shop or Other Activities:

STEP 4 - Lesson Summary and Review Items to be Used to Evaluate the Lesson Against the Lesson Objective:

INTERACTION ITEMS:

1. WHAT ARE THE ESSENTIAL PARTS OF AN ALTERNATING CURRENT GENERATOR?

   The essential parts of an A.C. generator are: field magnets, armature, and the collector with brushes and slip ring.

2. HOW DO YOU COUNT THE FREQUENCY OF AN ALTERNATING CURRENT?

   The frequency of an A.C. supplied by a generator is equal to the number of pairs of field poles multiplied by the number of rotation per second.

3. LIST TWO TYPES OF CONNECTIONS OF AN A.C. USED IN INDUSTRY TODAY.

   The Wye connection and the Delta connection.

4. TELL WHY A.C. MOTORS ARE WIDELY USED TODAY.

A) Most of the power is alternating current.
B) A.C. motors are less expensive than D.C. motors.

5. DESCRIBE WHAT THE LEFT HAND RULE FOR A MOTOR IS.

In the left hand rule, the forefinger always points in the direction of the magnetic flux (from N to S); the Center finger always points in the direction of the current (from positive to negative) and the thumb always points in the direction in which the conductor moves.

6. WHAT SHOULD BE TAKEN CARE OF WHEN MOTORS ARE USED?

A) Lubricate correctly.
B) Never put oil on the commutator or slip rings.
C) Should always be kept clean.

Lesson Plan # 5

Course Title/No. ROBOT SERVICE AND REPAIR Course # _____

Unit Title POWER SUPPLY Unit # 2

Unit Test Items Oral, Written, or Performance:

TRUE-FALSE

T 1. ALL A.C. GENERATORS WORK ON THE PRINCIPLE OF A MAGNETIC FIELD CUTTING THROUGH A CONDUCTOR.

T 2. IN THE REVOLVING ARMATURE AC. GENERATOR, THE STATUS PROVIDES A STATIONARY ELECTROMAGNETIC FIELD.

F 3. IN ORDER TO PRODUCE A 60-CYCLE CURRENT, A BIPOLAR GENERATOR MUST ROTATE 60 TIMES PER MINUTE.

F 4. IN AN AC. GENERATOR, THE MORE LINES OF FORCE TO BE CUT PER SECOND, THE LESS E.M.F. THERE IS TO BE INDUCED.

T 5. IN A DELTA CONNECTED AC. GENERATOR THERE IS MORE THAN ONE INTERNAL PATH FOR A CURRENT TO FLOW.

F 6. INCREASING THE SPEED OF ROTATION OF AN AC. GENERATOR IS THE RECOMMENDED METHOD OF INCREASING THE OUTPUT VOLTAGE.

T 7. GENERALLY SPEAKING, AC. MOTORS ARE LESS EXPENSIVE THAN D.C. MOTORS.

T 8. IN AN AC. INDUCTION MOTOR, THE ROTOR CURRENTS ARE SUPPLIED BY ELECTROMAGNETIC INDUCTION.

F 9. A SYNCHRONOUS MOTOR ROTATES AT A VARIABLE SPEED, WHICH DEPENDS ON THE FREQUENCY OF THE ALTERNATING CURRENT AND THE NUMBER OF POLES.

COMPLETION

1. THE ELECTROMAGNETS PROVIDING THE MAGNETIC FIELD ARE SUPPLIED BY direct current.
2. THE TWO MAJOR ASSEMBLIES OF AN AC. GENERATOR ARE THE stator AND THE rotor.
3. ANY POINT ON A CURVING LINE, SUCH AS THAT USED TO REPRESENT AN ALTERNATING CURRENT, IS CALLED A phase.
4. A CONDUCTOR IN FIELDS OF FOUR AND SIX POLES WILL PRODUCE two AND three CYCLES, RESPECTIVELY.

5. IN THREE-PHASE AC GENERATORS, THE STATOR IS SAID TO BE wye CONNECTED WHEN ONE LEAD FROM EACH PHASE IS CONNECTED TO A COMMON junction.
6. IN THE LEFT HAND RULE, THE THUMB ALWAYS POINTS IN THE DIRECTION IN WHICH THE conductor MOVES.
7. THE TWO MAIN TYPES OF AC MOTORS ARE Induction MOTORS AND synchronous MOTORS.
8. THE DIFFERENCE BETWEEN THE SPEED OF THE ROTATING FIELD IN THE STATO AND THE SPEED OF THE ROTOR IS KNOWN AS THE slip.
9. SINGLE-PHASE MOTORS ARE USED EXTENSIVELY IN COMMERCIAL AND INDUSTRIAL APPLICATIONS REQUIRING LESS THAN 5 HORSEPOWER.
10. THE ADVANTAGE OF USING A SINGLE-PHASE MOTOR IN A SMALL SIZE IS THAT IT IS less expensive TO MANUFACTURE THAN OTHER TYPES, AND THE ELIMINATE THE NEED FOR 3-PHASE A.C. POWER.

FREQUENCY OF AN ALTERNATING CURRENT

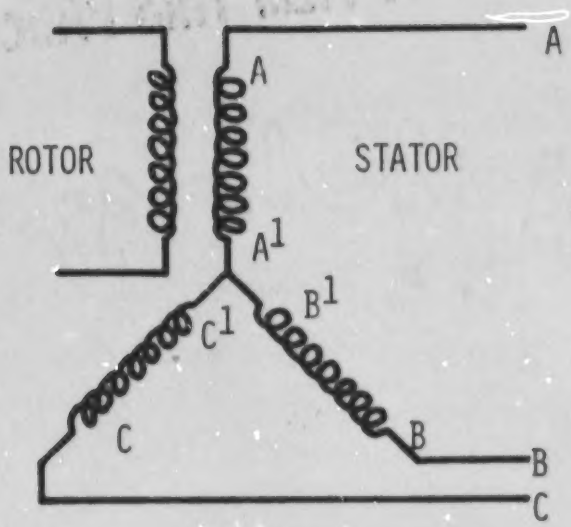
FORMULA:

$$F = \frac{SP}{60}$$

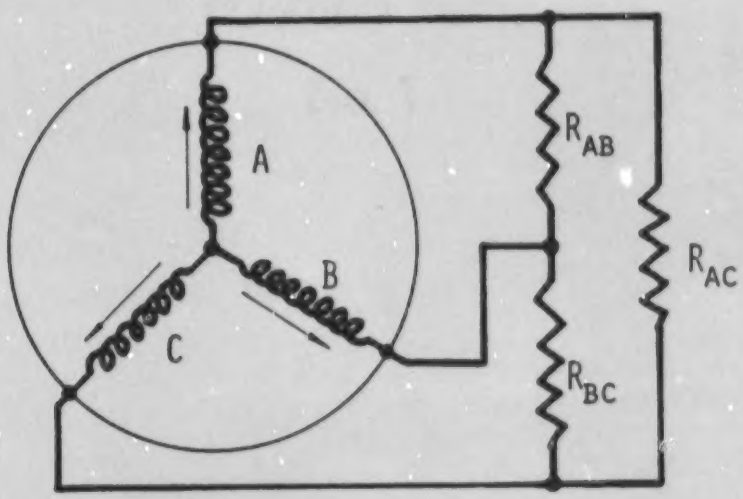
WHERE:

F = FREQUENCY, HZ
S = SPEED OF GENERATOR, R.P.M.
P = NUMBER OF PAIRS OF POLES
60 = CONVERSION FACTOR (F IN HZ AND S IN R.P.M.)

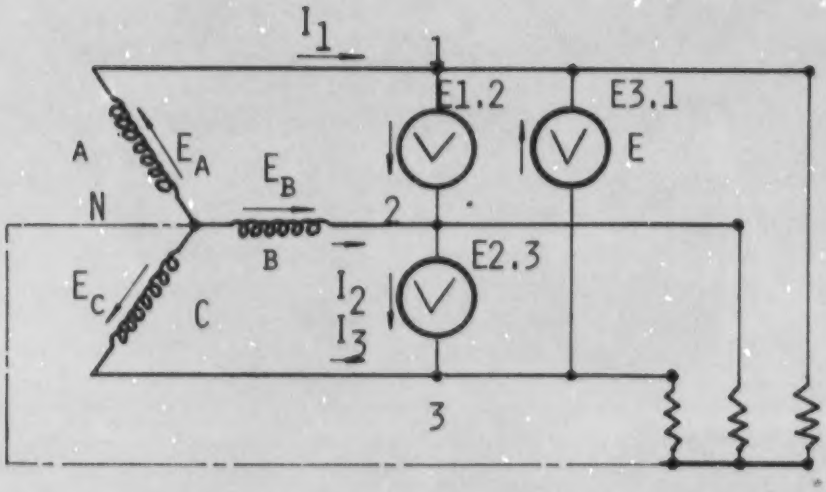
WYE CONNECTION



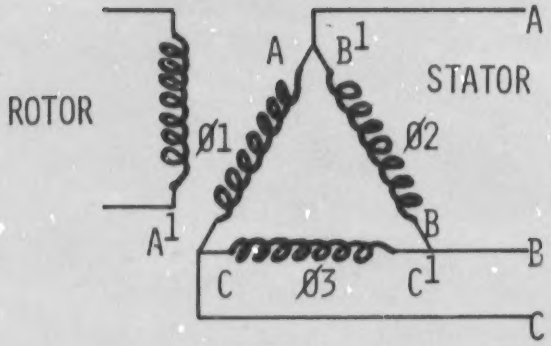
WYE CONNECTION IN ACTUAL APPLICATION

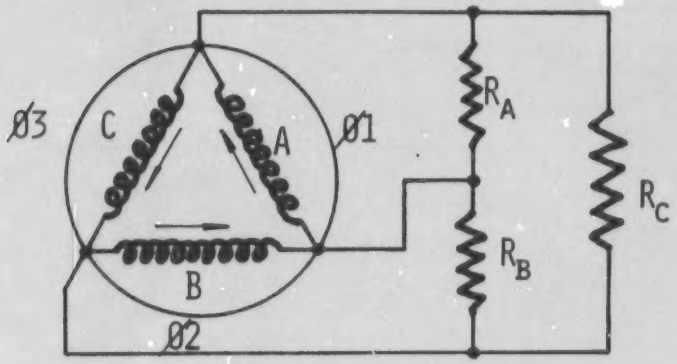


A THREE PHASE WYE CONNECTED A.C. GENERATOR

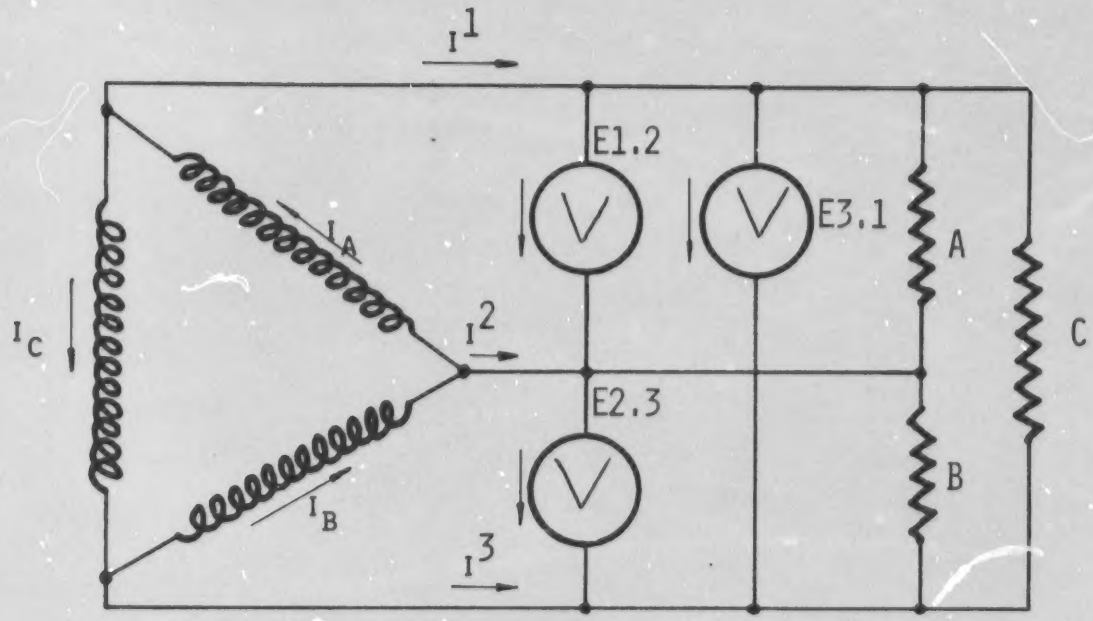


DELTA CONNECTION





A THREE PHASE DELTA CONNECTED A.C. GENERATOR



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THE MAJOR DIFFERENCE BETWEEN DELTA AND WYE CONFIGURATED GENERATORS

CONFIGURATION	E LINE	I LINE
WYE	1.73 E PHASE	I PHASE
DELTA	E PHASE	$\sqrt{3}$ x I PHASE

Lesson Plan # 6

Course Title ROBOT SERVICE AND REPAIR Course # _____

Unit Title POWER SUPPLY Unit # 2

Technical Information Lesson X General /Guidance Information Lesson ____

OR

Job Skill Demonstration Lesson _____

DC POWER

LESSON TITLE

Lesson Objective - Upon Completion of This Lesson the Student Should Be Able To:

1. VERBALLY DESCRIBE THE TYPES, CONSTRUCTIONS, AND FUNCTIONS OF THE BATTERIES.
2. VERBALLY EXPLAIN WHAT A DC GENERATOR IS AND TELL WHY IT IS REQUIRED.
3. VERBALLY DESCRIBE THE DC MOTOR, THE DC BRUSHLESS MOTOR, THE STEPPING MOTOR, AND THEIR USAGES.

Tools and Materials:

Teaching Aids:

1-6-H1 SYLLABUS SHEET
T2-6-1 THE EFFECTS OF ELECTRODE SIZE AND SEPARATION ON A SIMPLE CELL
T2-6-2 CELL CONNECTION
T2-6-3 CHARGE RETAINTION
T2-6-4 TYPES OF DC MOTORS

Informational Assignment:

INFORMATION SHEETS
IS2-6-1 BATTERIES
IS2-6-2 THE DC GENERATORS
IS2-6-3 THE DC MOTORS
ANSWER QUESTIONS FOUND ON ASSIGNMENT SHEET
AS2-6-1 DC POWER

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References:

1. BEAUCHAMP, W. L. AND MAYFIELD, J. C., BASIC ELECTRICITY, SCOTT, FORSMAN AND COMPANY, 1943.
2. MILLERMASTER, RALPH A., HARWOOD'S CONTROL OF ELECTRIC MOTORS, WILEY INTERSCIENCE, NEW YORK, 1970.
3. SAFFORD, E. L., THE COMPLETE HANDBOOK OF ROBOTICS, TAB BOOKS, 1978.

Step 1 - Introduction for Preparation of the Student:

MANY FUTURISTIC ROBOTIC APPLICATIONS WILL DICTATE THAT A ROBOT WILL HAVE A GREATER DEGREE OF FREEDOM OF MOVEMENT; THUS, THEY WILL DEMAND A POWER SOURCE THAT IS PORTABLE, RELIABLE, AND RENEWABLE. IN ORDER TO MEET THIS NEED, IT CAN BE ACHIEVED THROUGH THE USE OF RECHARGEABLE BATTERIES AND SMALL, POWERFUL, EASILY-CONTROLLED DC MOTORS.

IN THIS UNIT, THE STUDENT WILL LEARN AND KNOW THE BATTERIES THAT COULD POSSIBLY BE USED TO PROVIDE A REUSABLE POWER SOURCE, A DC MOTOR, AND HOW THEY WORK FOR A ROBOT.

Lesson Plan # 6

Course Title ROBOT SERVICE AND REPAIR Course # _____

Unit Title POWER SUPPLY Unit # 2

Lesson Title: DC POWER

STEP 2 - Presentation Outline:

I. BATTERIES
- A. TERMS OF BATTERIES
- B. THE SIMPLE CELLS
- C. THE EFFECT OF ELECTRODE SIZE AND SEPARATION (T2-6-1)
- D. THE DRY CELLS
- E. CELLS CONNECTION (T2-6-2)
- F. BATTERIES (T2-6-3)
- G. NICKEL-CADMIUM BATTERIES
- H. GELLED-ELECTROLYTE BATTERIES

II. THE DC GENERATOR
- A. INTRODUCTION
- B. DIRECT-CURRENT GENERATOR
- C. PRINCIPLE
- D. SELF-EXITED GENERATOR

III. THE DC MOTORS
- A. INTRODUCTION
- B. PRINCIPLE
- C. TYPES OF DC MOTORS (T2-6-4)
- D. MOTOR SELECTION FACTORS
- E. DC BRUSHLESS MOTORS

IV. THE STEPPING MOTORS
- A. DEFINITION
- B. SPECIFICATION

Lesson Plan # 6

Course Title ROBOT SERVICE AND REPAIR Course # _____

Unit Title POWER SUPPLY Unit # 2

STEP 3 - Classroom, Laboratory, Shop or Other Activities:

STEP 4 - Lesson Summary and Review Items to be Used to Evaluate the Lesson Against the Lesson Objective:

INTERACTIVE ITEMS

1. WHAT IS A CELL?

A cell is a device that transforms chemical energy into electrical energy. A cell is also the fundamental unit of the battery.

2. LIST THREE TYPES OF CELL CONNECTIONS.

a. series connection
b. parallel connection
c. series-parallel connection

3. WHAT ARE THE FEATURES OF NICKEL-CADMIUM BATTERIES?

a. maintenance free-sealed type
b. maintain constant voltage
c. high rates rechargeable
d. wide temperature range
e. long period of time of storage

4. LIST FIVE CHARGE METHODS OF THE BATTERIES.

a. trickle charge
b. minimum charge
c. standard charge
d. quick charge
e. rapid charge

5. WHY IS A DC GENERATOR NEEDED?

For some purposes, such as electrolysis, electroplating, charging storage batteries and communication work, direct current is needed. Cells or batteries supply direct current, but they are too expensive to use when large currrents must be provided for a considerable length of time. Therefore, a direct current generator is used to supply large amounts of direct current when it is needed.

6. LIST THREE THINGS THAT THE MECHANICAL ENERGY SUPPLIED BY A MOTOR DEPENDS UPON.

a. the number of turns in the armature coils
b. the amount of current flowing through the armature coils
c. the strength of the field magnets

7. WHAT ARE THE FACTORS OF SELECTING A DC MOTOR FOR A GIVEN APPLICATION.

There are two factors that must be taken into consideration:

a. speed range
b. speed control under load

Lesson Plan # 6

Course Title/No. ROBOT SERVICE AND REPAIR Course # _____

Unit Title POWER SUPPLY Unit # 2

Unit Test Items Oral, Written, or Performance:

TRUE-FALSE

____ 1. THE SECONDARY CELL MEANS THAT AN ELECTRICAL CELL CAN BE RECHARGEABLE.

____ 2. THE VOLTAGE OF A SIMPLE CELL DOES NOT CHANGE AS THE ELECTRODES ARE INCREASED IN SIZE.

____ 3. THE NICKEL-CADMIUM BATTERIES ARE LESS EXPENSIVE THAN LEAD ACID BATTERIES.

____ 4. CONSTANT CURRENT CHARGING IS THE PREFERRED METHOD TO CHARGE THE NICKEL-CADMIUM BATTERIES.

____ 5. THE GELLED-ELECTROLYTE BATTERIES HAVE A VERY WIDE OPERATION TEMPERATURE RANGE; DURING DISCHARGE IS FROM 10° F TO 100° F.

____ 6. IN DC GENERATORS, THE MORE THE NUMBER OF ARMATURE COILS THEY HAVE, THE STRONGER AND SMOOTHER THE CURRENT WILL BE.

____ 7. THE DC BRUSHLESS MOTOR HAS ONE COMMON DISADVANTAGE, WHICH IS THE MECHANICAL SWITCHING ACTION THAT CAUSES COMMUTATOR WEAR.

____ 8. THE CONTINUOUS ROTATING BRUSHLESS MOTOR IS STILL NOT POPULAR TODAY.

____ 9. WITH STEPPING MOTORS, THE FEEDBACK SIGNALS WILL BE NEEDED FOR THE SYSTEMS.

COMPLETION

1. THE AMPERAGE OF A SIMPLE CELL INCREASES AS THE ELECTRODES ARE INCREASED IN _____ AND THE DISTANCE BETWEEN THE ELECTRODES IS _____.
2. THE CELL IS THE FUNDAMENTAL UNIT OF THE _____.
3. THERE ARE THREE METHODS OF CONNECTING ELECTRICAL CELLS; _____, _____, AND _____.
4. RAPID CHARGING IS FOR THOSE APPLICATIONS THAT REQUIRE RECHARGING IN LESS THAN _____ HOURS.
5. NICKEL-CADMIUM CELLS OR BATTERIES SHOULD BE USED IN _____; CONNECTING THEM IN _____ IS NOT RECOMMENDED.

6. THE CAPACITY OF A CELL IS EXPRESSED IN _____.
7. IN DC GENERATORS, THEY ALWAYS HAVE ROTATING _____ AND STATIONARY _____.
8. IF THE APPLICATION REQUIRES A DECREASE IN MOTOR SPEED WHEN THE LOAD IS INCREASED, A _____ MOTOR IS TO BE USED.
9. IN A STEPPING MOTOR, THE POSITION, SPEED AND DIRECTION ARE EASY TO _____.

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Lesson Plan # 6

Course Title/No. ROBOT SERVICE AND REPAIR Course # _____

Unit Title POWER SUPPLY Unit # 2

Unit Test Items Oral, Written, or Performance:

TRUE-FALSE

T 1. THE SECONDARY CELL MEANS THAT AN ELECTRICAL CELL CAN BE RECHARGEABLE.

T 2. THE VOLTAGE OF A SIMPLE CELL DOES NOT CHANGE AS THE ELECTRODES ARE INCREASED IN SIZE.

F 3. THE NICKEL-CADMIUM BATTERIES ARE LESS EXPENSIVE THAN LEAD ACID BATTERIES.

T 4. CONSTANT CURRENT CHARGING IS THE PREFERRED METHOD TO CHARGE THE NICKEL-CADMIUM BATTERIES.

F 5. THE GELLED-ELECTROLYTE BATTERIES HAVE A VERY WIDE OPERATION TEMPERATURE RANGE; DURING DISCHARGE IS FROM 10° F TO 100° F.

T 6. IN DC GENERATORS, THE MORE THE NUMBER OF ARMATURE COILS THEY HAVE, THE STRONGER AND SMOOTHER THE CURRENT WILL BE.

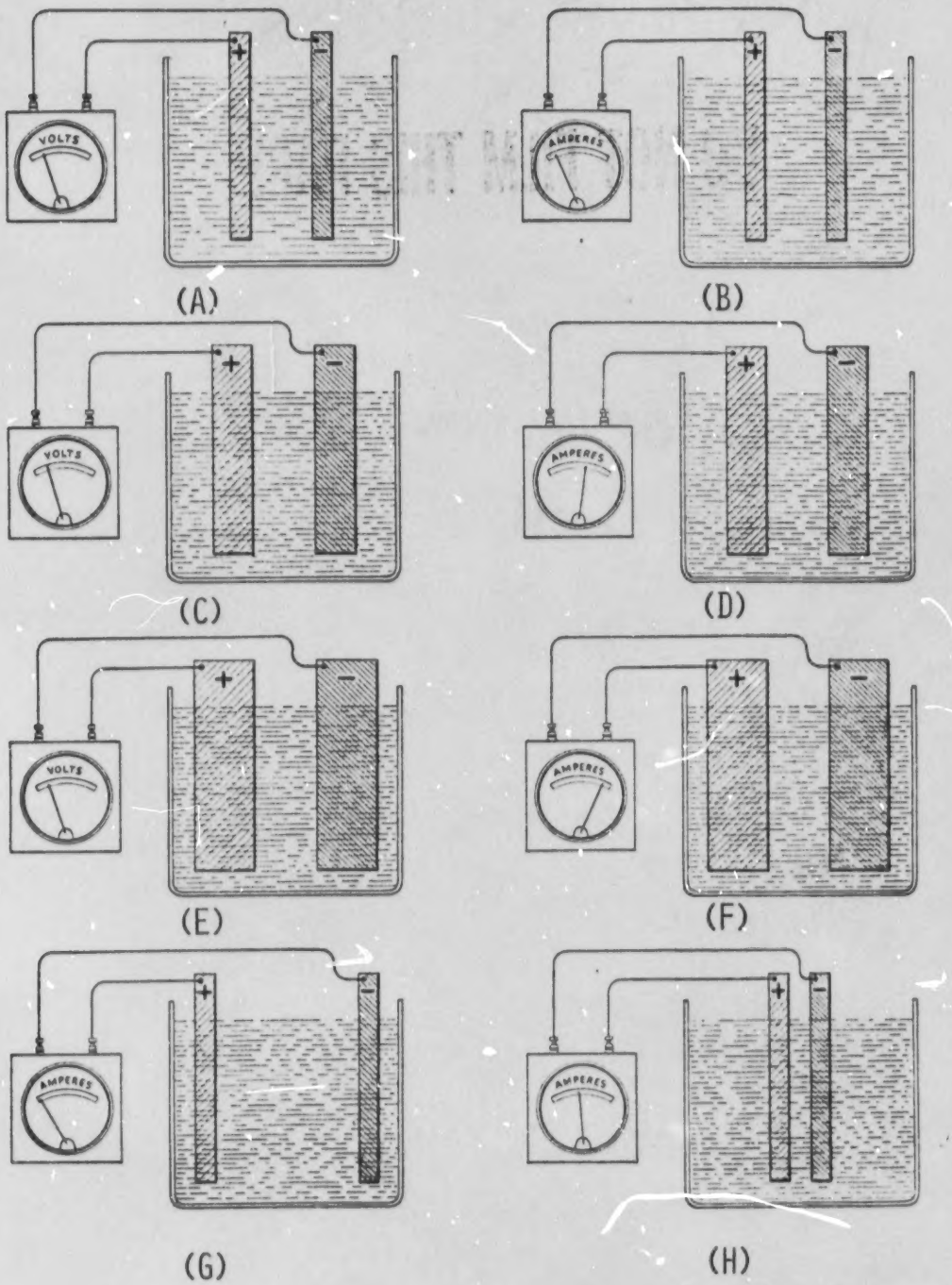
F 7. THE DC BRUSHLESS MOTOR HAS ONE COMMON DISADVANTAGE, WHICH IS THE MECHANICAL SWITCHING ACTION THAT CAUSES COMMUTATOR WEAR.

F 8. THE CONTINUOUS ROTATING BRUSHLESS MOTOR IS STILL NOT POPULAR TODAY.

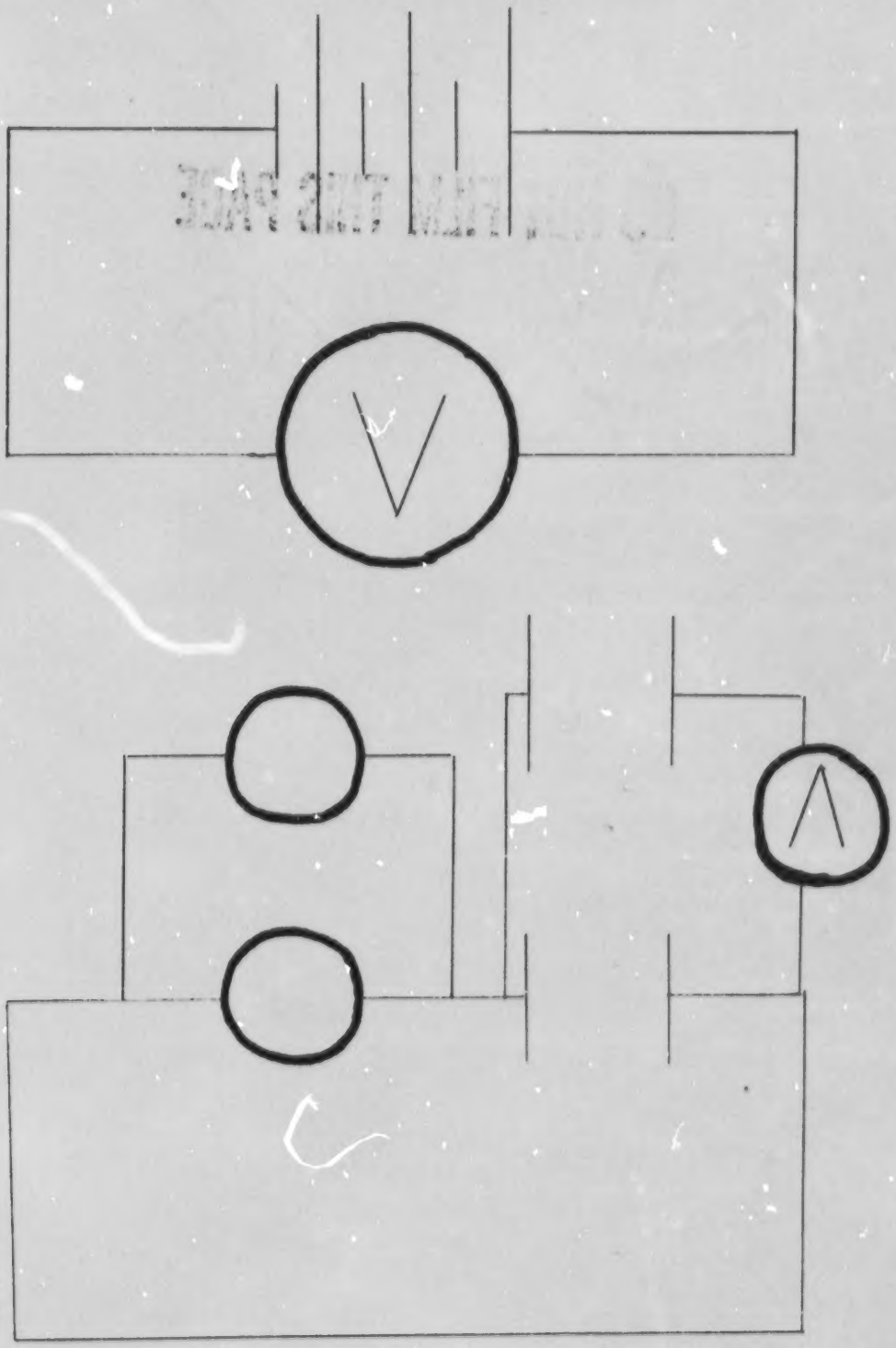
F 9. WITH STEPPING MOTORS, THE FEEDBACK SIGNALS WILL BE NEEDED FOR THE SYSTEMS.

COMPLETION

1. THE AMPERAGE OF A SIMPLE CELL INCREASES AS THE ELECTRODES ARE INCREASED IN size AND THE DISTANCE BETWEEN THE ELECTRODES IS decreased.
2. THE CELL IS THE FUNDAMENTAL UNIT OF THE battery.
3. THERE ARE THREE METHODS OF CONNECTING ELECTRICAL CELLS; in series, in parallel, AND series-parallel.
4. RAPID CHARGING IS FOR THOSE APPLICATIONS THAT REQUIRE RECHARGING IN LESS THAN 3 HOURS.
5. NICKEL-CADMIUM CELLS OR BATTERIES SHOULD BE USED IN series; CONNECTING THEM IN parallel IS NOT RECOMMENDED.



THE EFFECT OF ELECTRODE SIZE AND SEPARATION ON A SIMPLE CELL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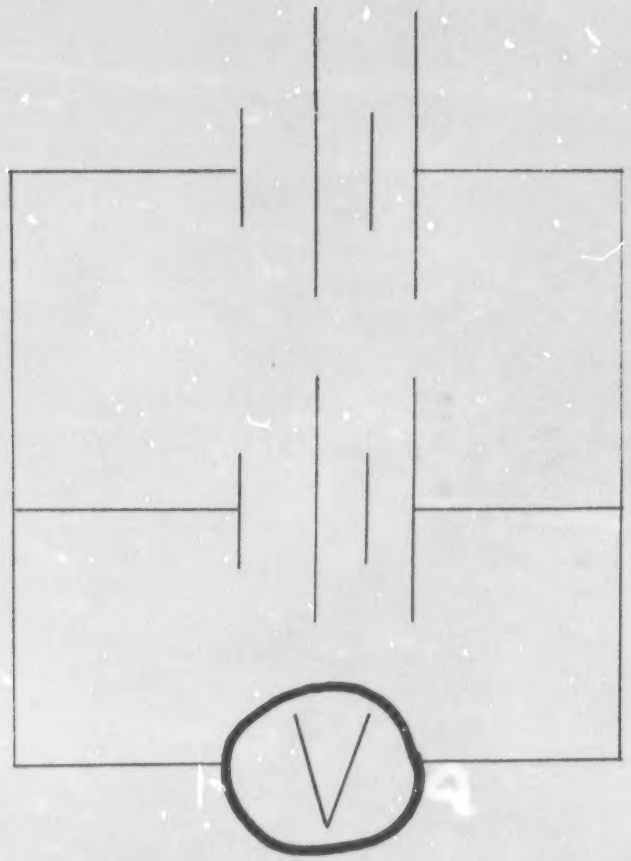
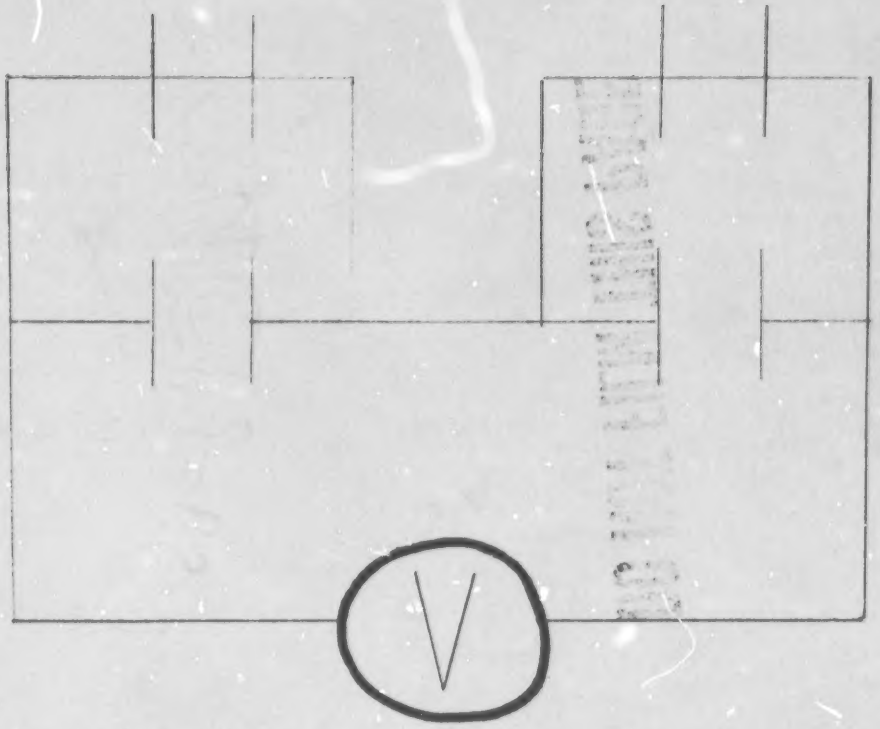




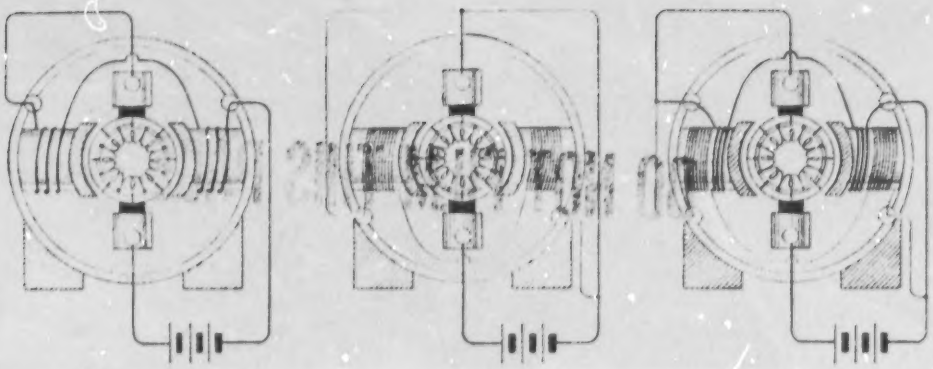
CELL CONNECTIONS

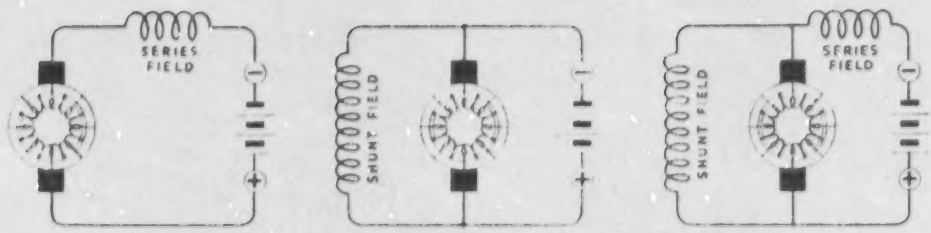
163

164

CHARGE RETAINTION

ITEM	CELL TYPE	1 MONTH	2 MONTHS	5 MONTHS
1	RECTANGULAR	75%	70%	63%
2	BUTTON	75%	70%	63%
3	CYLINDRICAL	75%	50%	15%





(A) (B) (C)

TYPES OF DC MOTORS

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LESSON PLAN #6

UNIT 2-- DC POWER

ASSIGNMENT SHEET 1

AFTER READING THE INFORMATION SHEET (IS2-6-1 AND IS2-6-3) PROVIDED, COMPLETE THE FOLLOWING QUESTIONS IN WRITING OR AS REQUESTED BY YOUR INSTRUCTOR.

1. DEFINITION:
   A. CELL- A cell consists of two different electrodes inan electrolyte.
   B. ELECTRODE-The plates or terminals of an electrical cell or a battery.
   C. PRIMARY CELL-An electrical cell that can not be rechargeable.
   D. SECONDARY CELL-An electrical cell that can be rechagreable.
   E. CAPACITY-The total amount of electrical energy that can be obtained from a fully-charged cell.

2. THERE ARE THREE TYPES OF SELF EXITED GENERATORS. WHAT ARE THEY?
   1. the series generator
   2. the shunt generator
   3. the compound generator

3. WHAT ARE THE TWO MAJOR REASONS OF DC MOTORS TO BE WIDELY USED IN ROBOTIC APPLICATION?
   1. Their speed-torque relationship can be varied, providing a wide range of application.
   2. They are readily adaptable to a variety of control circuit, especially simple logi- and microprocessor control.

4. THE DC MOTOR HAS EXACTLY THE SAME PARTS AS A DC GENERATOR; THEY ARE:
   1. field magnets
   2. armature
   3. commutator and brushes

5. WHAT ARE THE THREE BASIC TYPES OF DC MOTORS?

1. the series motor
2. the shunt motor
3. the compound motor

6. A STEPPING MOTOR HAS 240 STEPS PER REVOLUTION. COMPUTE HOW MANY DEGREES PER STEP FOR ROTATING.

answer: $\frac{360}{240} = 1.5^{\circ}$

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Lesson Plan # 4

Course Title ROBOT SERVICE AND REPAIR Course # _____

Unit Title ROBOT CONTROL SYSTEM Unit # 3

Technical Information Lesson X General /Guidance Information Lesson ____

OR

Job Skill Demonstration Lesson _____

INTRODUCTION TO PROGRAMMING

LESSON TITLE

Lesson Objective - Upon Completion of This Lesson the Student Should Be Able To:

1. VERBALLY DEFINE THE TERMS: INSTRUCTION, PROGRAM, WORD, BYTE, MPU, MEMORY, BUS, ADDRESS, OPERAND, OPCODE, ETC.
2. DEVELOP FLOW CHARTS THAT ILLUSTRATE STEP BY STEP PROCEDURE FOR SOLVING SIMPLE PROBLEMS.
3. WRITE A SIMPLE PROGRAM THAT CAN MULTIPLY BY REPEATED ADDITION; DIVIDE BY REPEATED SUBTRACTION, ETC.

Tools and Materials:

Teaching Aids:

H3-4-1 SYLLABUS SHEET
T3-4-1 A BASIC MICROCOMPUTER
T3-4-2 ARITHMETIC LOGIC UNIT
T3-4-3 THE RANDOM ACCESS MEMORY
T3-4-4 MICROCOMPUTER OPERATION
T3-4-5 INSTRUCTION AND DATA FORMAT
T3-4-6 THE PROGRAM IN MEMORY
T3-4-7 THE SEQUENCE OF INSTRUCTION
T3-4-8 DIRECT ADDRESSING MODE INSTRUCTIONS
T3-4-9 FLOW CHART OF MULTIPLYING BY REPEATED ADDITION
T3-4-10 FLOW CHART OF DIVIDING BY REPEATED SUBTRACTION

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Pittsburg State University

Informational Assignment:

IS3-4-1 MICROCOMPUTER AND PROGRAM CONCEPTS
IS3-4-2 THE TYPES OF OPERATIONS THAT THE MICROCOMPUTER PERFORMS
IS3-4-3 PROGRAMMING FUNDAMENTALS
IS3-4-4 ARITHMETIC PROBLEMS
ANSWER QUESTIONS FOUND ON ASSIGNMENT SHEETS
AS3-4-1 INTRODUCTION TO PROGRAMMING

References:

1. LEVENTHAL, L.A., 6800 ASSEMBLY LANGUAGE PROGRAMMING. OSBORNE AND ASSOCIATES, INC., CALIFORNIA, 1978.
2. RONY, P.R., INTRODUCTORY EXPERIMENTS IN DIGITAL ELECTRONICS AND 8080A MICROCOMPUTER PROGRAMMING AND INTERFACING. HOWARD W. SAMS AND CO., INC., INDIANA, 1982.
3. STOCKHAHN, A.D. AND OTTER J.D., INDUSTRIAL APPLICATIONS FOR MICRO-PROCESSORS. RESTON PUBLISHING CO., INC., VIRGINIA, 1982.

Step 1 - Introduction for Preparation of the Student:

MOST OF TODAY'S MORE SOPHISTICATED ROBOTS USE SOME SORT OF COMPUTER CONTROL. THROUGH PROGRAMMING A MICROPROCESSOR, THIS ALLOWS A ROBOT TO PERFORM SPECIFIC PREDETERMINED TASKS. ALSO, BY ITS INTERFACING ABILITY, THE MICROPROCESSOR ALLOWS A ROBOT TO ESTABLISH COMMUNICATIONS AND FUNCTION WITH THE OUTSIDE WORLD.

IN THIS UNIT, THE STUDENT WILL LEARN TO PROGRAM THE MICROPROCESSOR. THE PROGRAMS ARE VERY SIMPLE. BY STUDYING THESE PROGRAMS, THE STUDENT WILL DEVELOP AN UNDERSTANDING OF HOW THE MICROPROCESSOR HANDLES MORE COMPLEX TASKS. BY THE WAY, THE STUDENTS WILL GAIN PRACTICE USING THE INSTRUCTION SET.

Lesson Plan # 4

Course Title ROBOT SERVICE AND REPAIR Course # _____

Unit Title ROBOT CONTROL SYSTEM Unit # 3

Lesson Title: INTRODUCTION TO PROGRAMMING

STEP 2 - Presentation Outline:

I. MICROCOMPUTER AND PROGRAM CONCEPT
   - A. MICROCOMPUTER (T3-4-1)
   - B. MICROCOMPUTER PROGRAMMING
   - C. COMPUTER WORDS AND WORD LENGTHS
   - D. THE MAJOR REGISTERS AND CIRCUITS OF A MICROPROCESSOR (T3-4-2, T3-4-3, T3-4-4)

II. THE TYPES OF OPERATIONS THE MICROPROCESSOR PERFORMS
   - A. MOVE A BYTE FROM ONE LOCATION TO ANOTHER
   - B. ARITHMETIC AND LOGICAL OPERATION
   - C. MISCELLANEOUS OPERATION

III. PROGRAMMING FUNDAMENTALS
   - A INSTRUCTION SET
   - B. INSTRUCTION CODE MNEMONICS
   - C. INSTRUCTION AND DATA FORMATS (T3-4-5)
   - D. A SAMPLE PROGRAM (T3-4-6)
   - E. ADDRESSING MODES
     1. INHERENT OR IMPLIES ADDRESSING
     2. IMMEDIATE ADDRESSING
     3. DIRECT ADDRESSING
   - F. PROGRAM EXAMPLE
     1. ONE COMPLEMENT
     2. 8-BIT ADDITION
   - G. BRANCHING
     1. LOOPING (T3-4-7)
     2. RELATIVE ADDRESSING (T3-4-8)
     3. CONDITION BRANCHING

IV. ARITHMETIC PROBLEMS
   - A. MULTIPLYING BY REPEATED ADDITION (T3-4-9)
   - B. DIVIDING BY REPEATED SUBTRACTION (T3-4-10)

Lesson Plan # 4

Course Title ROBOT SERVICE AND REPAIR Course # _____

Unit Title ROBOT CONTROL SYSTEM Unit # 3

STEP 3 - Classroom, Laboratory, Shop or Other Activities:

STEP 4 - Lesson Summary and Review Items to be Used to Evaluate the Lesson Against the Lesson Objective:

1. WHAT ARE THE THREE TYPES OF BUSES USED IN A MICROCOMPUTER?

DATA BUS-It is a bidirectional data path by which data is transferred between the MPU, memory, and 2/0 devices.

ADDRESS BUS-An undirectional bus over which digital information appears to identify either a particular memory location or a 2/0 devices.

CONTROL BUS-A set of signals that regulate the operation of a microcomputer system, including 2/0 devices and memory.

2. THE PORTIONS OF THE MICROCOMPUTER IN WHICH INSTRUCTIONS AND DATA ARE STORED IN ARE CALLED THE:

A. ALU C. MPU
B. RAM D. Data Bus

3. IN MICROPROCESSOR TERMINOLOGY, THE NUMBER OR PIECE OF DATA THAT IS IN OPERATION IS CALLED THE:

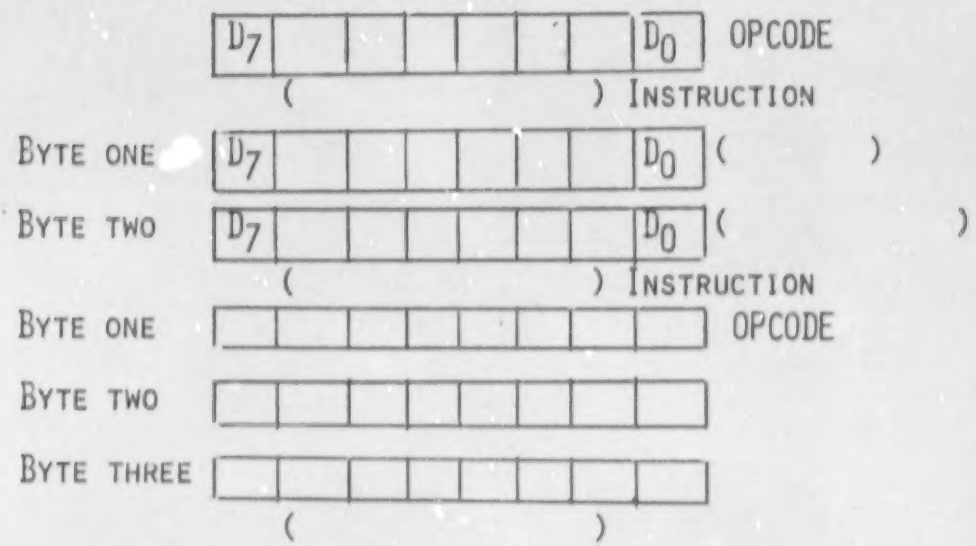
   A. Instruction
   B. Opcode
   C. Operand
   D. Address

4. IN THE IMMEDIATE ADDRESSING MODE, THE SECOND BYTE OF THE INSTRUCTION IS THE number that is to be operated upon

5. Halt IS NORMALLY A 1-BYTE INSTRUCTION.

6. A DISADVANTAGE OF DIRECT ADDRESSING IS THAT THE OPERAND MUST BE IN THE FIRST 256_{10} BYTE'S OF MEMORY.

7. COMPLETE THE FOLLOWING INSTRUCTIONS AND DATA FORMAT.



COMPLETION

1. IN A MICROCOMPUTER, A GROUP OF PARALLEL CONDUCTORS THAT CARRY INFORMATION IS CALLED A __bus__.
2. THE __word__ IS THE FUNDAMENTAL UNIT OF INFORMATION USED IN THE COMPUTER.
3. A PROGRAM IS A GROUP OF __instruction__ THAT ALLOWS THE COMPUTER TO PERFORM A SPECIFIC JOB.
4. A MEMORY CONSISTS OF __FF_{16} or 256_{10}__ LOCATIONS, EACH OF WHICH CAN STORE AN 8-BIT.
5. IN THE DIRECT ADDRESSING MODE, THE SECOND OF TWO INSTRUCTION BYTES IS THE ADDRESS OF THE __operand__.
6. EACH MEMORY LOCATION HAS TWO 8-BIT BINARY MEMBERS ASSOCIATED WITH IT, ONE IS ITS __address__, THE OTHER IS ITS __contents__.
7. THE PROGRAM LOOP IS THE BASIC STRUCTURE THAT FORCES THE CPU TO __repeat__ A SEQUENCE OF INSTRUCTIONS.
8. ALL BRANCH INSTRUCTIONS ARE __two__ BYTE INSTRUCTIONS.
9. A __positive__ TOW'S COMPLEMENT NUMBER CAUSES A BRANCH FORWARD.

TRUE-FALSE

__F__ 1. THE BYTE IS THE FUNDAMENTAL UNIT OF INFORMATION USED IN THE COMPUTER.

__T__ 2. A "STORED PROGRAM" IS STORED IN THE COMPUTER'S MEMORY.

__T__ 3. IN AN INSTRUCTION SET, THE ABBREVIATED VERSION OF AN INSTRUCTION IS REFERRED TO AS A MNEMONIC.

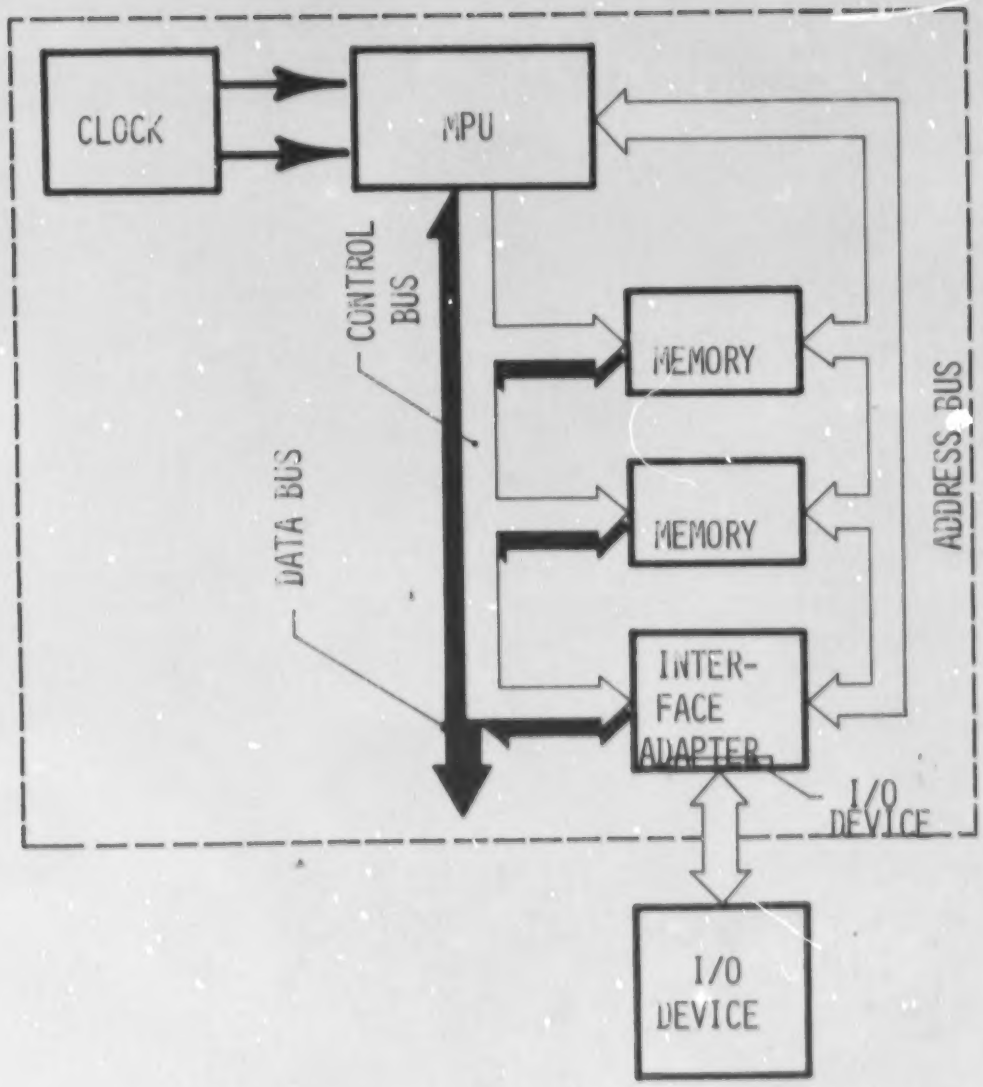
__F__ 4. IMMEDIATE AND DIRECT ADDRESSING MODES MAY NOT BE COMBINED IN THE SAME PROGRAM.

__T__ 5. THE FORM OF ADDRESSING IS SPECIFIED THAT THE SECOND BYTE IS THE ADDRESS OF THE OPERAND.

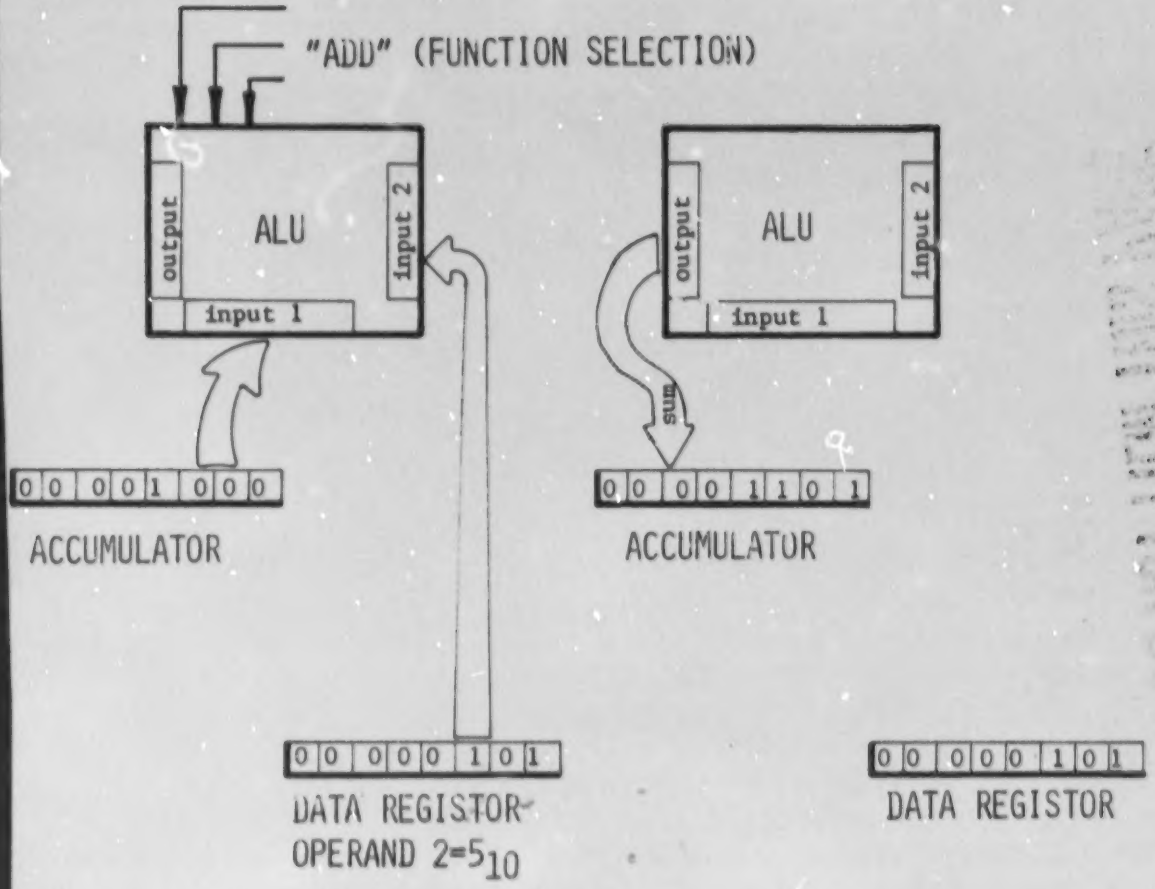
__F__ 6. IN THE IMMEDIATE ADDRESSING MODE, AN ADDRESS IS GIVEN.

__T__ 7. THE BRANCH INSTRUCTION ALLOWS THE MICROPROCESSOR UNIT TO JUMP FORWARD OVER A BLOCK OF DATA OR OVER A PORTION OF A PROGRAM.

__F__ 8. MOST MICROPROCESSORS HAVE HARDWARE MULTIPLE CAPABILITIES.

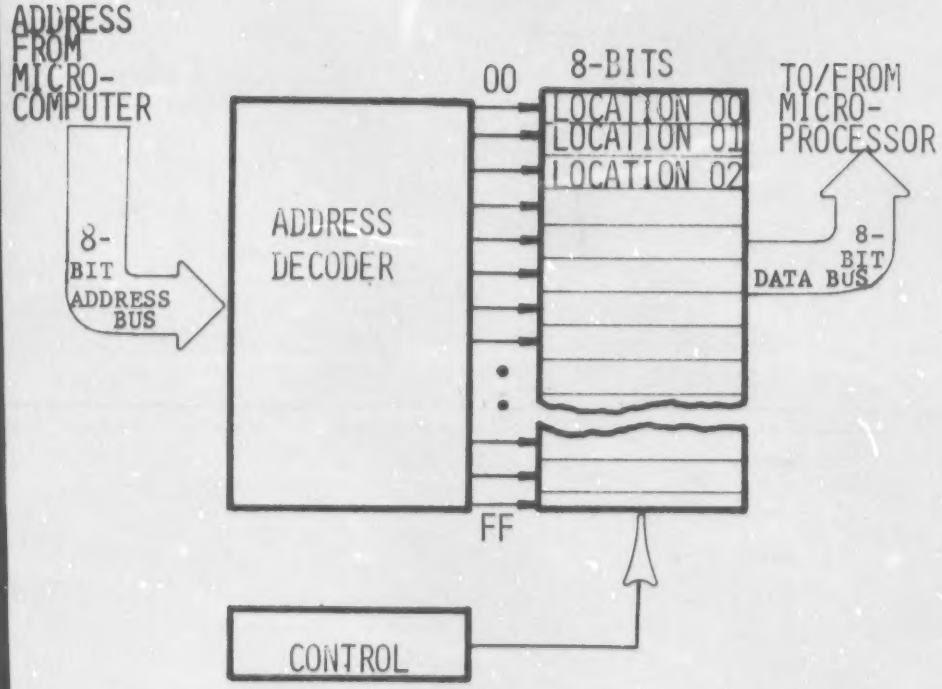


A BASIC MICROCOMPUTER



ARITHMETIC LOGIC UNIT

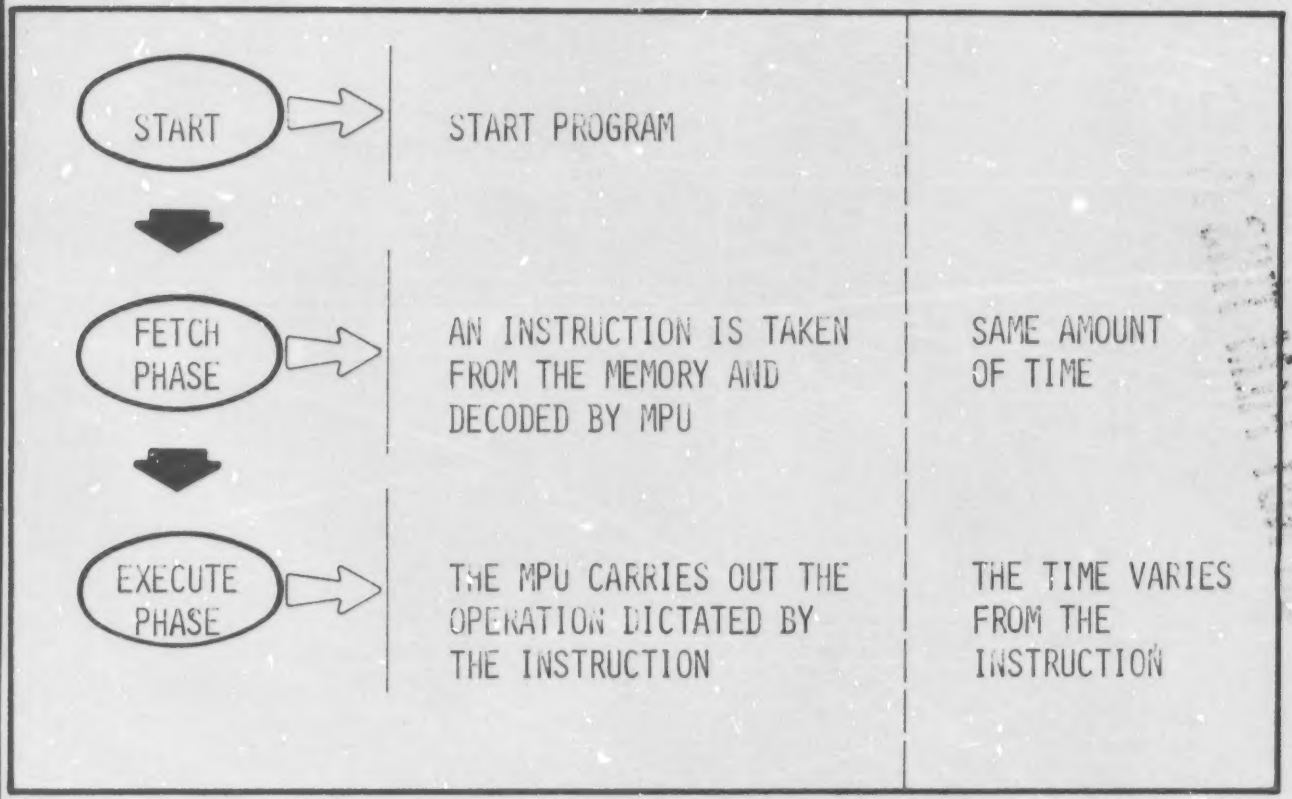
THE RANDOM ACCESS MEMORY



READ/WRITE COMMAND
FROM MICROPROCESSOR

T3-4-3

MICROCOMPUTER OPERATION


START
START PROGRAM
FETCH PHASE
AN INSTRUCTION IS TAKEN FROM THE MEMORY AND DECODED BY MPU
SAME AMOUNT OF TIME
EXECUTE PHASE
THE MPU CARRIES OUT THE OPERATION DICTATED BY THE INSTRUCTION
THE TIME VARIES FROM THE INSTRUCTION

SINGLE BYTE INSTRUCTION

TWO BYTE INSTRUCTION

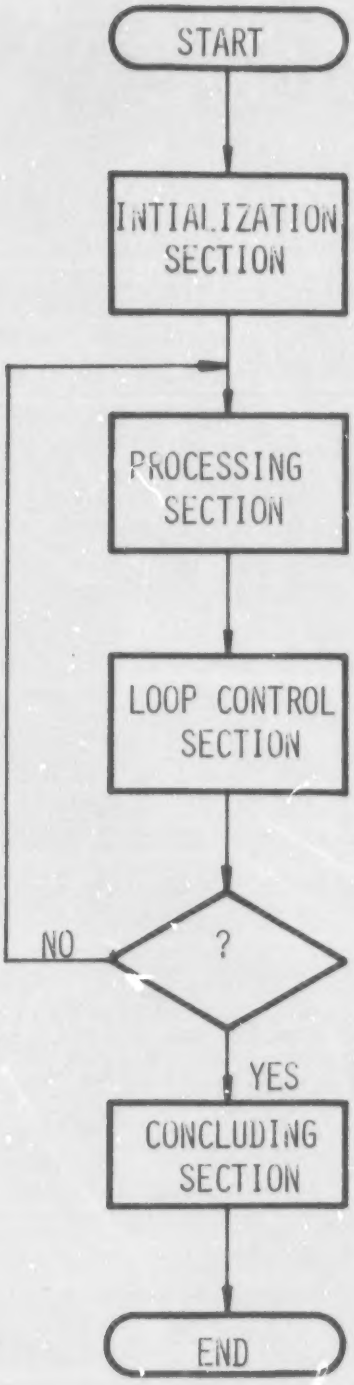
THREE BYTE INSTRUCTION

INSTRUCTION & DATA FORMAT

ADDRESS		MEMORY (BINARY CONTENTS)	MNEMONIC (DECIMAL CONTENTS)
HEX	BINARY		
00	00000000	10000110	LD/2
01	00000001	00000111	7
02	00000010	10001011	ADD
03	00000011	00001011	10
04	00000100	00111110	HLT
	•	•	
	•	•	
	•	•	
	•	•	
	•	•	
	•	•	
	•	•	
	•	•	
	•	•	
	•	•	
FD	11111101		
FE	11111110		
FF	11111111		

THE PROGRAM IN MEMORY

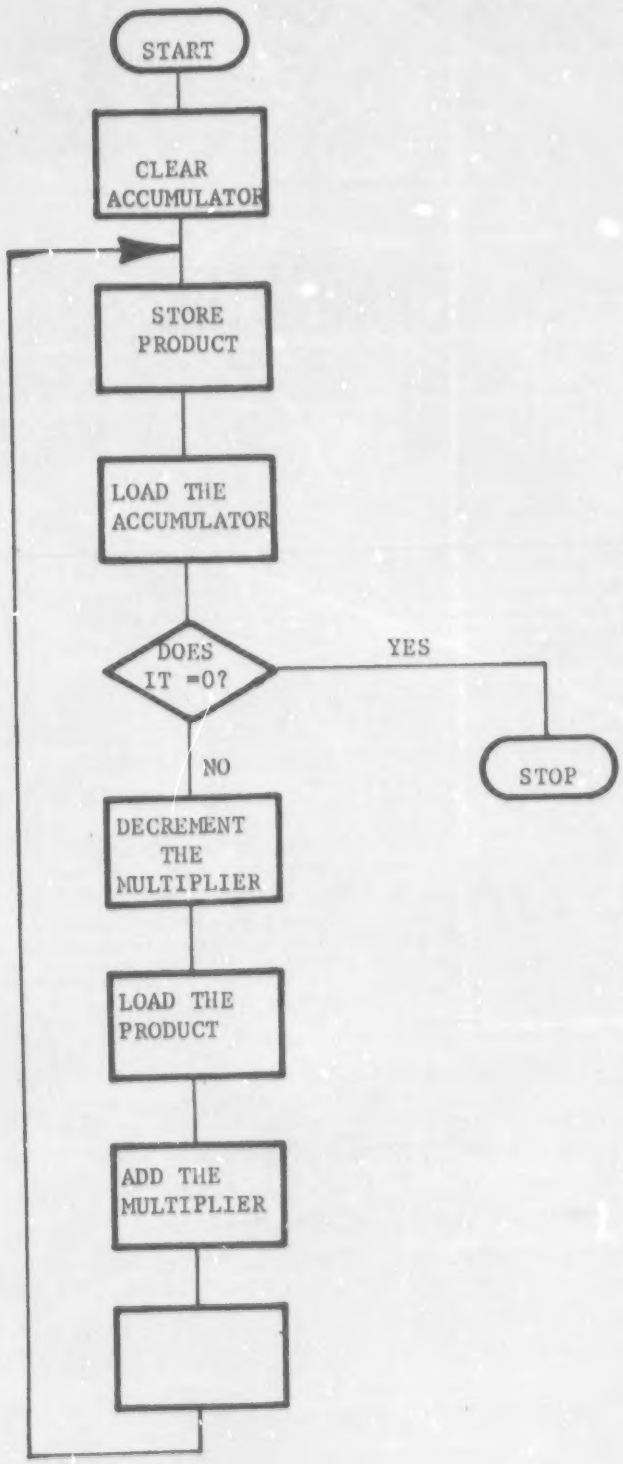
THE SEQUENCE OF INSTRUCTION



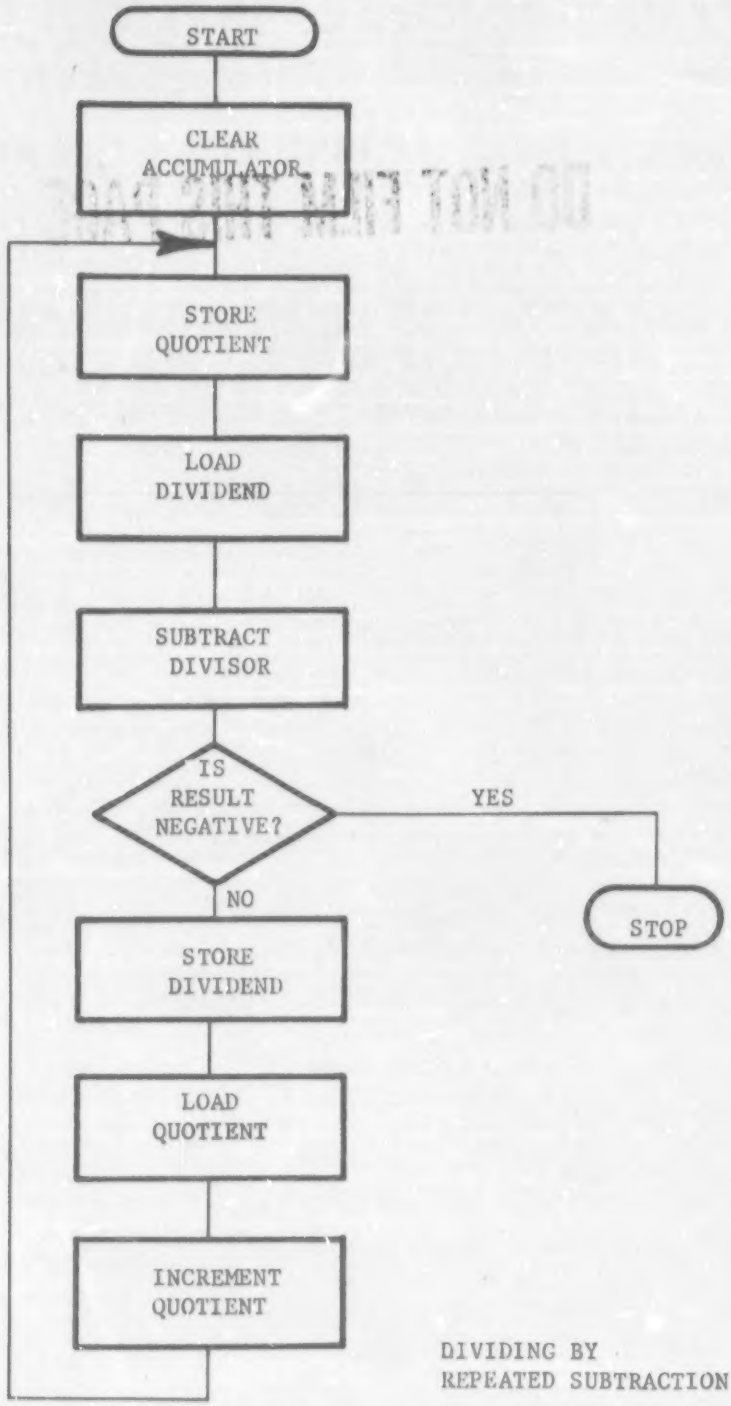
HAS THE TASK BEEN COMPLETED?

NAME	MNEMONIC	OPCODE	DESCRIPTION
LOAD ACCUMULATOR	LDA	10010110_2 OR 96_{16}	LOAD THE CONTENTS OF THE MEMORY LOCATION WHOSE ADDRESS IS GIVEN BY THE NEXT BYTE INTO THE ACCUMULATOR.
ADD	ADD	10011011_2 OR 96_{16}	ADD THE CONTENTS OF THE MEMORY LOCATION WHOSE ADDRESS IS GIVEN BY THE NEXT BYTE TO THE PRESENT CONTENTS OF THE ACCUMULATOR--PLACE THE SUM IN THE ACCUMULATOR.
STORE ACCUMULATOR	STA	10010111_2 OR 97_{16}	STORE THE CONTENTS OF THE ACCUMULATOR IN THE MEMORY LOCATION WHOSE ADDRESS IS GIVEN BY THE NEXT BYTE.

T3-4-8



MULTIPLYING BY REPEATED ADDITION



DIVIDING BY
REPEATED SUBTRACTION

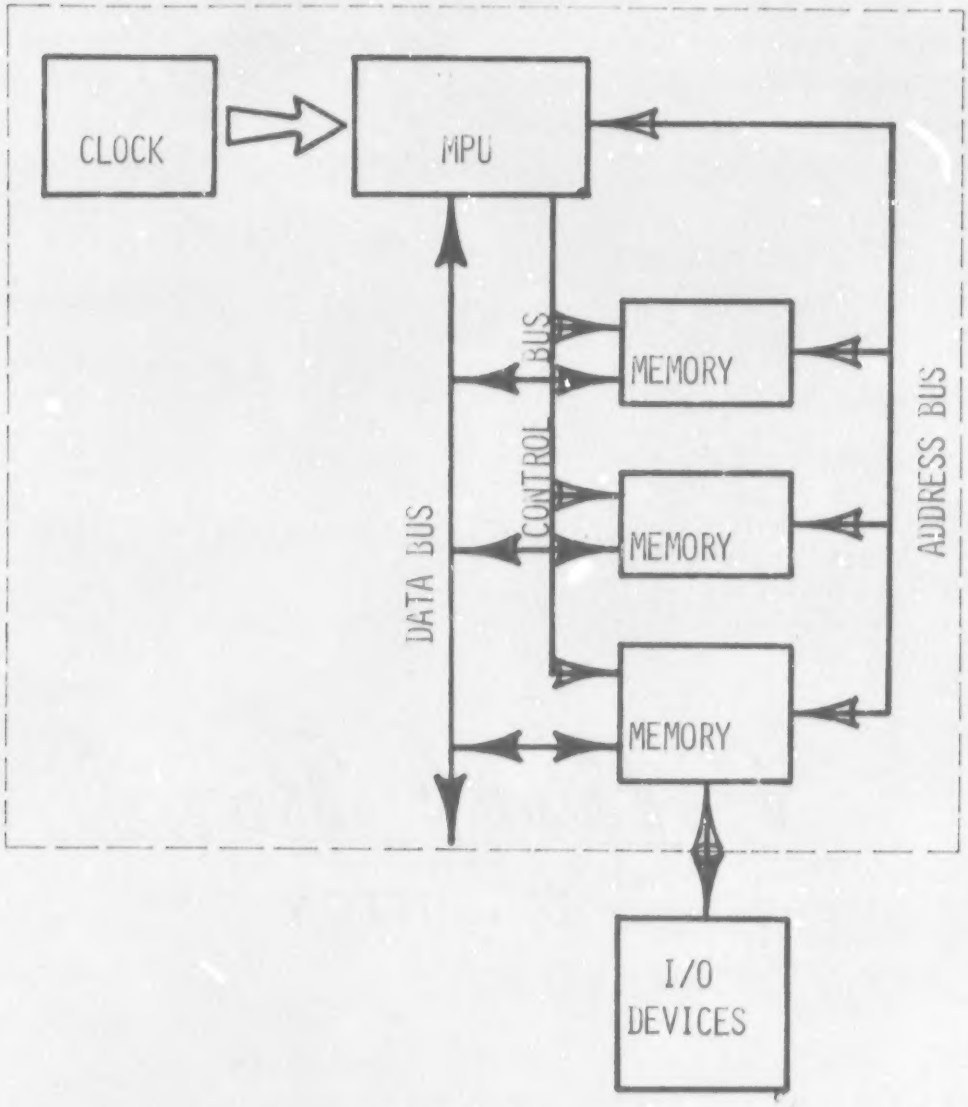
LESSON PLAN #4

UNIT 3--INTRODUCTION TO PROGRAMMING

ASSIGNMENT SHEET 1

AFTER READING THE INFORMATION SHEET PROVIDED, COMPLETE THE FOLLOWING QUESTIONS IN WRITING OR AS REQUESTED BY YOUR INSTRUCTOR.

1. DRAW A DIAGRAM TO EXPLAIN THE THREE TYPES OF BUSES THAT ARE USED IN A MICROCOMPUTER.



A. Data Bus--It is a bidirectional data path by which data is transferred between the MPU, memory, and I/O devices.
B. Address Bus--An undirectionalbus over which digital information appears to identify either a particular memory location or an I/O device.
C. Control Bus--A set of signals that regulate the operation of a microcomputer system. They function much like "traffic signals"or commands.

2. WHAT IS THE FUNCTION OF THE ARITHMETIC LOGICAL UNIT OF THE MICROCOMPUTER?

The ALU of a microcomputer is to perform arithmetic or logic operations on the data word that is delivered to it.

3. WHAT DOES RAM AND ROM MEAN? AND WHAT IS THE DIFFERENCE BETWEEN THE TWO?

RAM--Random Access Memory, it acts as a temporary storage location.
ROM--Read Only Memory, it is a permanent storage area for programs or contents.

4. WHAT ARE THE ADVANTAGES OF INHERENT ADDRESSING?

A. Requires little memory space.
B. Requires a minimum of execute time.

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5. IF WE WISH TO BRANCH TO THE INSTRUCTION AT ADDRESS 12_{16}, THE OPCODE FOR THE BRANCH INSTRUCTION IS ATE ADDRESS $0A_{16}$, WHAT RELATIVE ADDRESS IS REQUIRED AT THE LOCATION $0B_{18}$ IN ORDER TO IMPLEMENT THIS BRANCH?

ADDRESS (HEX)	CONTENTS (HEX)	MNEMONICS
0A	20	BRA
0B	?	?
0C	--	--
0D	--	--
0E	--	--
0F	--	--
10	--	--
11	--	--
12	--	--
13	--	--
14	--	--
15	--	--

00010010_2 12_{16}

$- \underline{00001100_2}$ $\underline{0C}$

00000110_2 06_{16} --------relative address

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Lesson Plan # 1

Course Title ROBOT SERVICE AND REPAIR Course # _____

Unit Title ROBOT CONTROL SYSTEM Unit # 3

Technical Information Lesson X General /Guidance Information Lesson ____

OR

Job Skill Demonstration Lesson _____

BASIC CONTROL SYSTEM OF A ROBOT

LESSON TITLE

Lesson Objective - Upon Completion of This Lesson the Student Should Be Able To:

Tools and Materials:

Teaching Aids:

H3-1-1 SYLLABUS
T3-1-1 CONTROL SYSTEM
T3-1-2 A POTENTIAL TRANSDUCER
T3-1-3 TRANSISTOR
T3-1-4 SYNCHRO-TRANSMITTER
T3-1-5 SYNCHRO-RECEIVER
T3-1-6 DIFFERENTIAL SYNCHRO-TRANSMITTER
T3-1-7 DIFFERENTIAL SYNCHRO-RECEIVER
T3-1-8 CONTROL TRANSFORMER

Informational Assignment:

IS3-1-1 TYPES OF SYSTEMS
IS3-1-2 FEEDBACK AND TRANSDUCER
IS3-1-3 OTHER TRANSDUCERS
IS3-1-4 SYNCHRO-SYSTEM
ANSWER QUESTIONS FOUND ON ASSIGNMENT SHEETS
AS3-1-1 BASIC CONTROL SYSTEM OF A ROBOT

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Department of Vocational Technical Education
Room 110 Willard Hall
Phone 316-231-7000 ext 415
Pittsburg State University

Individualized Informational Assignment for Special Students:

References:

1. GROOVER, M.P. AUTOMATION, PRODUCTION SYSTEMS, AND CAM. PRENTIC
HALL, INC., N.J., 1980.
2. SAFFORD, E.L. THE COMPLETE HANDBOOK OF ROBOTICS, TAB BOOKS, 197

Step 1 - Introduction for Preparation of the Student:

MUCH OF THE INFORMATION USED IN INDUSTRIAL CONTROL AND ROBOTICS
OBTAINED IN ANALOG FORM AND USED OR DISPLAYED IN THE SAME ANALOG FOR
SYNCHRO-SYSTEMS AND SERVO MECHANISMS ARE ONE OF THE PRIMARY METHODS
OF ACQUIRING ANALOG INFORMATION, CONVERTING IT TO ELECTRICAL INFORMA
AND THEN USING THE ELECTRICAL SIGNALS TO PRODUCE AN ANALOG DISPLAY
OR CONTROL FUNCTION.

IN THIS UNIT, THE STUDENT WILL LEARN THE CONTROL SYSTEM AND THE
BASIC SYNCHRO-SYSTEM USED IN DISPLAY AND CONTROL ANALOG FUNCTIONS.

Lesson Plan # 1

Course Title ROBOT SERVICE AND REPAIR Course # _____

Unit Title ROBOT CONTROL SYSTEM Unit # 3

Lesson Title: BASIC CONTROL SYSTEM OF A ROBOT

STEP 2 - Presentation Outline:

I. TYPE OF SYSTEM.
   A. OPEN-LOOP SYSTEM.
   B. CLOSED-LOOP SYSTEM.
   C. DIFFERENCES IN SYSTEM.

II. FEEDBACK AND TRANSDUCERS.
   A. FEEDBACK.
   B. TRANSDUCERS.

III. OTHER TRANSDUCERS.

IV. SYNCHRO-SYSTEM.
   A. TRANSMITTER.
   B. RECEIVER.
   C. DIFFERENTIAL SYNCHRO-TRANSMITTER.
   D. DIFFERENTIAL SYNCHRO-RECEIVER.
   E. CONTROL TRANSFORMER.

Lesson Plan # 1

Course Title ROBOT SERVICE AND REPAIR Course # _____

Unit Title ROBOT CONTROL SYSTEM Unit # 3

STEP 3 - Classroom, Laboratory, Shop or Other Activities:

STEP 4 - Lesson Summary and Review Items to be Used to Evaluate the Lesson Against the Lesson Objective:

1. WHAT IS A OPEN-LOOP SYSTEM?

   A system in which the input does not depend upon what happens a[illegible] output of the system.

2. WHAT IS THE DIFFERENCE BETWEEN AN OPEN-LOOP SYSTEM AND A CLOSED-LOOP SYSTEM?

   A closed-loop system is one in which the input does depend on what the output is doing, but the open-loop system is not.

3. WHAT IS THE MAIN PURPOSE OF A TRANSDUCER?

   The main purpose of a transducer is use for converting a physical quantity output such as light, pressure, or a mechanical motion to an electrical signal to make comparison of their size.

4. HOW MANY TYPES OF SYNCHRO-DEVICES ARE USED IN A SYNCHRO-SYSTEM?

   There are five basic types of synchro-devices:

   A. Transmitter
   B. Receiver
   C. Differential synchro-transmitter
   D. Differential synchro-receiver
   E. Control transformer

Lesson Plan # 1

Course Title/No. ROBOT SERVICE AND REPAIR Course # _____

Unit Title ROBOT CONTROL SYSTEM Unit # 3

Unit Test Items Oral, Written, or Performance:

TRUE AND FALSE

F 1. AN OPEN-LOOP SYSTEM IS ONE THAT HAS A FEATURE OF FEEDBACK IN WHICH THE INPUT DOES DEPEND ON WHAT THE OUTPUT IS DOING.

T 2. ALL AUTOMATIC HEATING AND COOLING SYSTEMS ARE EXAMPLES OF CLOSED-LOOP SYSTEMS.

T 3. THE MOST POPULAR FEEDBACK SIGNAL USED IN THE CONTROL SYSTEM IS THE ELECTRIC SIGNAL.

T 4. THE ANGULAR POSITION COULDBE A REPRESENTATIVE OF A TEMPERATURE OR PRESSURE GAUGE SETTING, OR THE LATERAL POSITION OF A ROBOT.

F 5. THE DIFFERENTIAL TRANSMITTER CONTAINS FOUR SEPARATE WINDINGS, WHICH ARE DISPLACED 90°.

MATCHING

B 1.	A SYSTEM DESIGNED TO BE SELF-CORRECTING AND TO ADJUST THEIR OUTPUT.	A. OPEN LOOP. B. FEEDBACK SYSTEM. C. TRANSDUCER. D. TRANSMITTER. E. SYNCHRO-RECEIVER.
A 2.	A WASHING MACHINE.	
E 3.	SOMETIMES CALLED A SYNCHRO-MOTOR.	
D 4.	SYNCHRO-GENERATOR.	
C 5.	POTENTIOMETER.	

CONTROL SYSTEM

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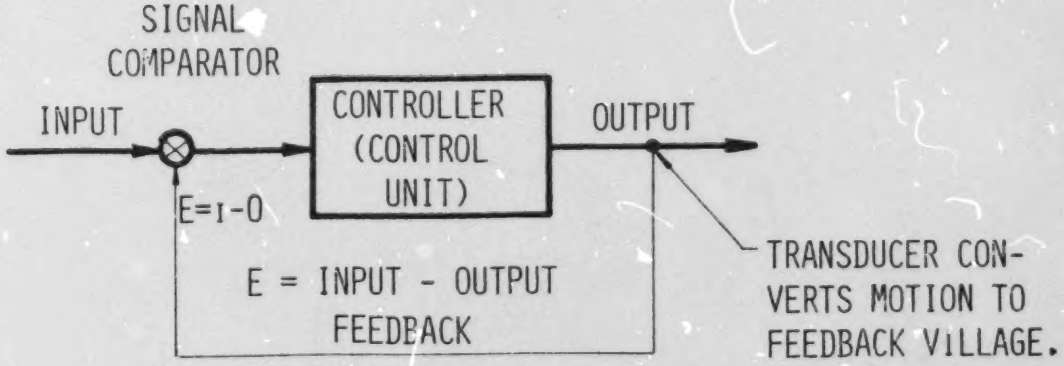
(A) OPEN-LOOP



(B) CLOSED-LOOP

A POTENTIAL TRANSDUCER

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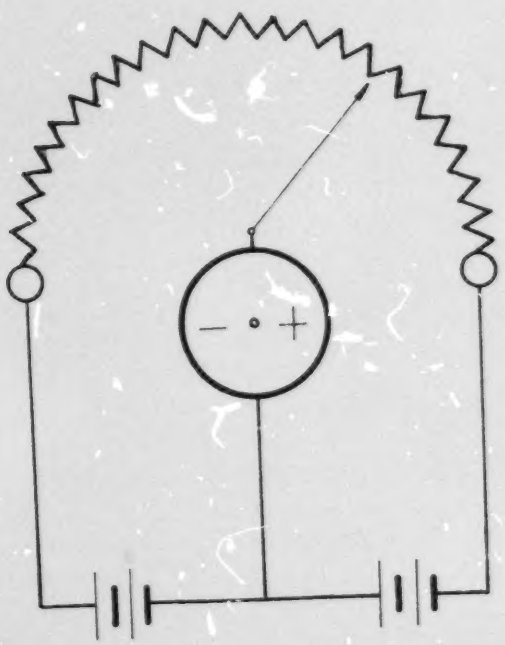
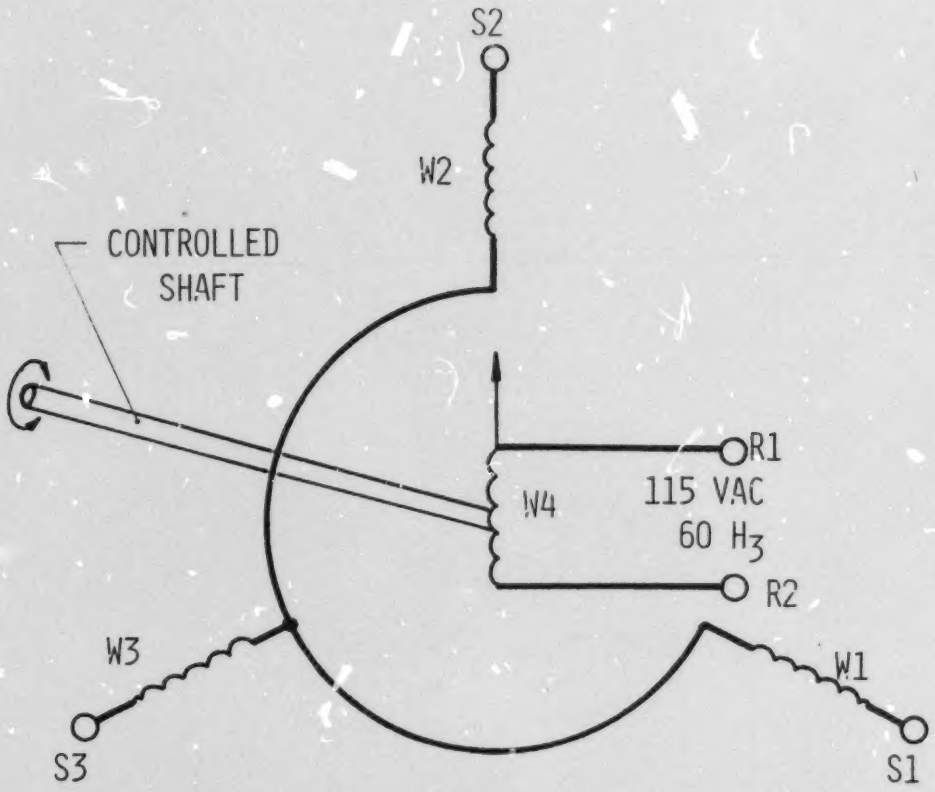


SYNCHRO-TRANSMITTER



W1, W2, W3: STATOR WINDING
W4: ROTOR WINDING

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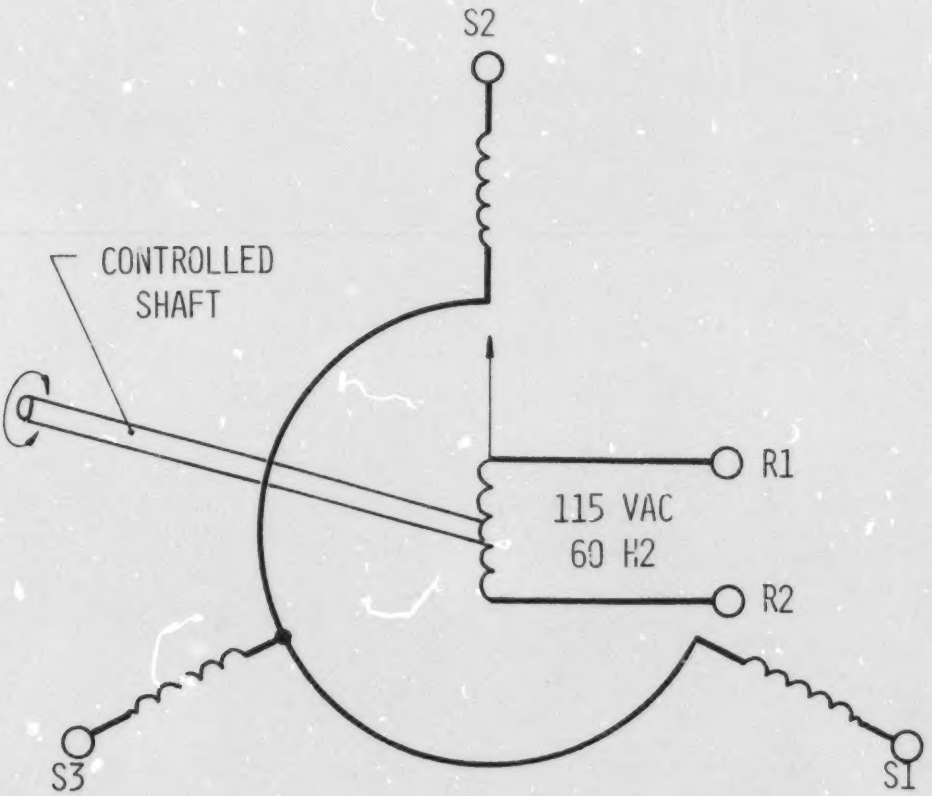
SYNCHRO-RECEIVER



S1, S2, S3: TO SYNCHRO-TRANSMITTER

DIFFERENTIAL SYNCHRO-TRANSMITTER

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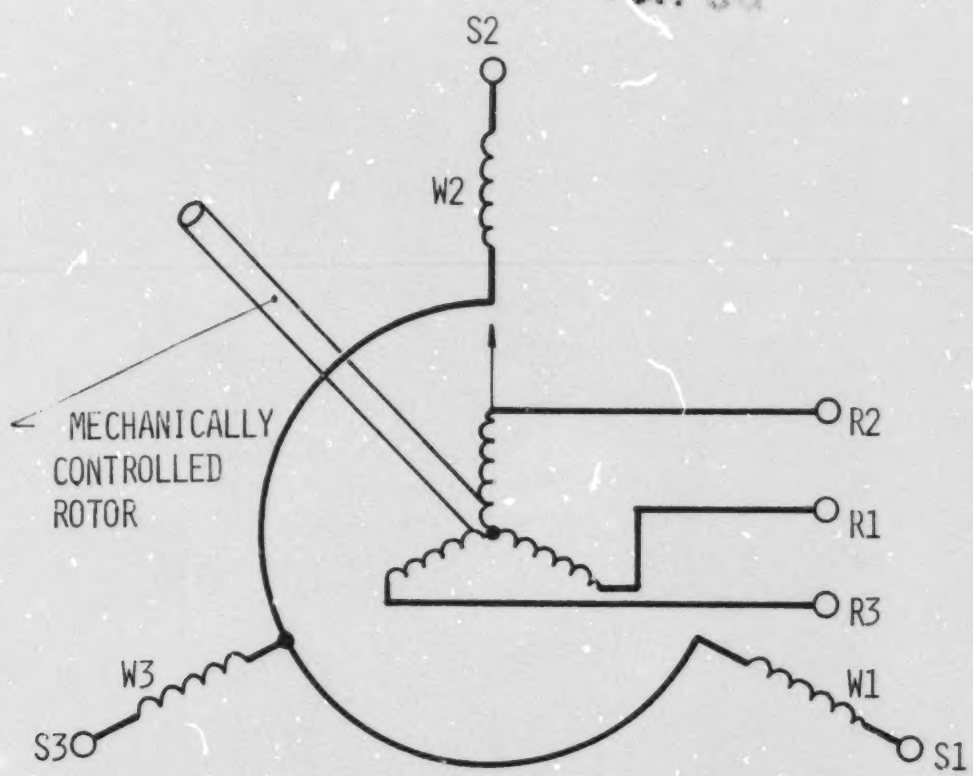
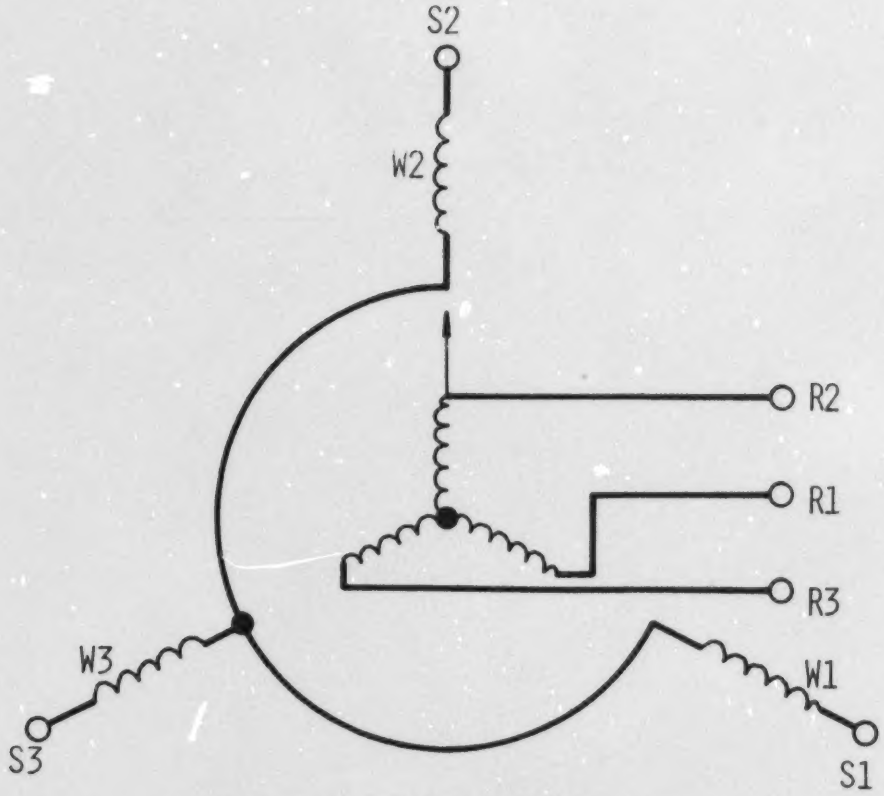


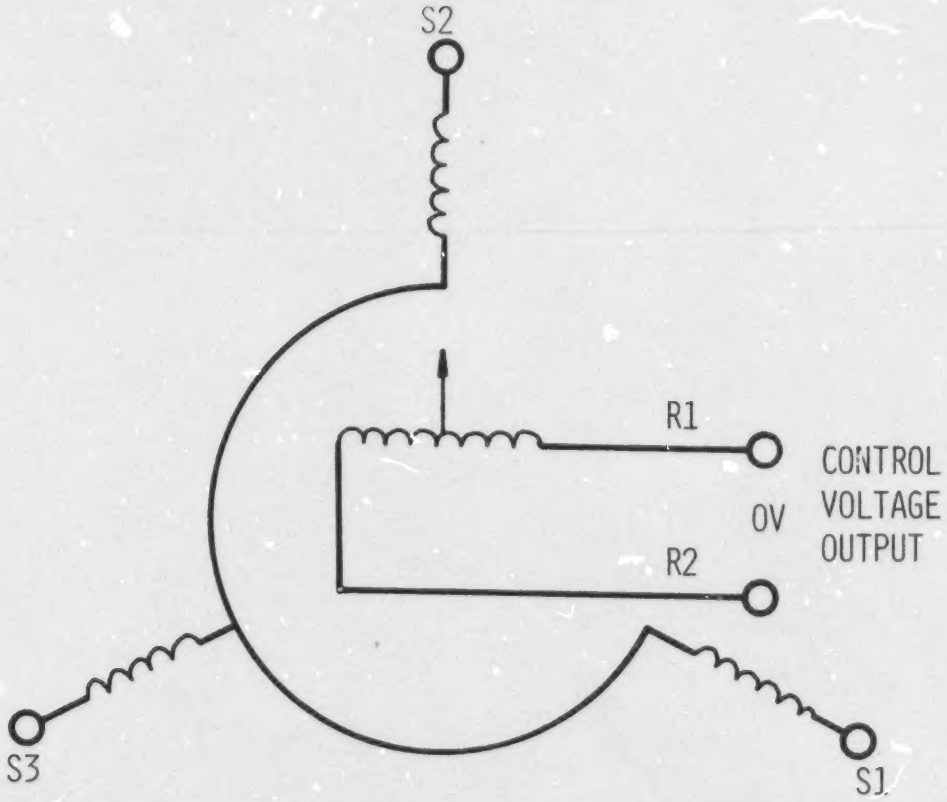
W1, W2, W3: TO SYNCHRO-TRANSMITTER
R1, R2, R3: TO SYNCHRO-RECEIVER

DIFFERENTIAL SYNCHRO-RECEIVER



W1, W2, W3: TO TRANSMITTER #1
R1, R2, R3: TO TRANSMITTER #2

CONTROL TRANSFORMER



S1, S2, S3: FROM SYNCHRO-
TRANSMITTER

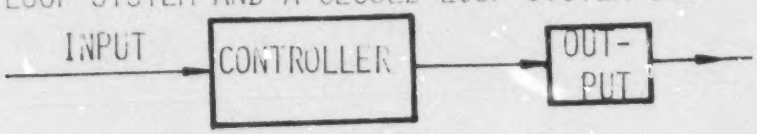
LESSON PLAN #1

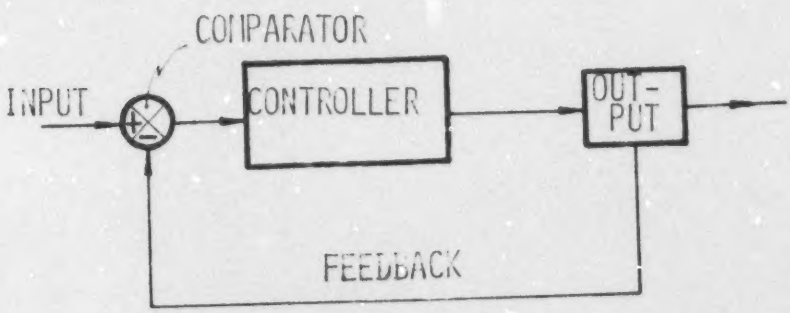
UNIT 3--ROBOT CONTROL SYSTEM

ASSIGNMENT SHEET 1

AFTER READING THE INFORMATION SHEETS (IS3-1-1, IS3-1-2, IS3-1-3, AND IS3-1-4) PROVIDED, COMPLETE THE FOLLOWING QUESTIONS IN WRITING OR AS REQUESTED BY YOUR INSTRUCTOR.

1. MAKE A DIAGRAM TO EXPLAIN WHAT THE DIFFERENCE BETWEEN AN OPEN-LOOP SYSTEM AND A CLOSED-LOOP SYSTEM IS.





2. WHAT ARE THE ATTRIBUTES OF CLOSED-LOOP SYSTEMS AS COMPARED TO OPEN-LOOP SYSTEMS?

A. Improve accuracy.
B. Increase in the bandwidth of the system and improved performance.
C. Decrease the effect of distortion and nonlinearities.

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Lesson Plan # 2

Course Title ROBOT SERVICE AND REPAIR Course # _____

Unit Title ROBOT CONTROL SYSTEM Unit # 3

Technical Information Lesson X General /Guidance Information Lesson ____

OR

Job Skill Demonstration Lesson _____

SENSOR AND INTERFACING

LESSON TITLE

Lesson Objective - Upon Completion of This Lesson the Student Should Be Able To:

Tools and Materials:

Teaching Aids:

H3-2-1 SYLLABUS
T3-2-1 WHAT IS A SENSOR?
T3-2-2 SENSING STEPS
T3-2-3 SENSORS: NON-CONTACT
T3-2-4 SENSORS: CONTACT
T3-2-5 METHODS OF SENSOR INTERFACE TO THE ROBOT
T3-2-6 SENSORS
T3-2-7 HOW SENSORS DIFFER

Informational Assignment:

IS3-2-1 SENSOR
IS3-2-2 SENSOR AND INTERFACING
IS3-2-3 HOW SENSORS DIFFER
ANSWER QUESTIONS FOUND ON ASSIGNMENT SHEETS
AS3-2-1 SENSOR AND INTERFACING

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Department of Vocational Technical Education
Room 136 Willard Hall
Phone 316-231-7000 ext. 417
Pittsburg State University

Individualized Informational Assignment for Special Students:

References:

1. GROOVER, M.P. AUTOMATION, PRODUCTION SYSTEMS AND COMPUTER AIDED MANUFACTURING. PRENTICE HALL, INC., N.J. 1980.
2. SAFFORD, E.L. THE COMPLETE HANDBOOK OF ROBOTICS. TAB BOOKS, 1978.

Step 1 - Introduction for Preparation of the Student:

IN ORDER TO LET THE ROBOTS ACHIEVE A FREEDOM OF MOVEMENT AND TO PERFORM USEFUL FUNCTIONS, THE ROBOT MUST HAVE THE CAPABILITIES TO SENSE AND ACT UPON ITS SURROUNDING ENVIRONMENT.

IN THIS LESSON, THE STUDENT WILL STUDY SOME OF THE METHODS THAT ARE USED TO SENSE THE VARIOUS PARAMETERS A ROBOT MUST MONITOR IN ORDER TO PERFORM A CERTAIN FUNCTION. IN ADDITION, THE STUDENT WILL LEARN HOW A SENSOR INTERFACES WITH ROBOTS.

Lesson Plan # 2

Course Title ROBOT SERVICE AND REPAIR Course # _____

Unit Title ROBOT CONTROL SYSTEM Unit # 3

Lesson Title: SENSOR AND INTERFACING

STEP 2 - Presentation Outline:

I. SENSORS
   A. INTERNAL ROBOTIC SENSING
   B. EXTERNAL ROBOTIC SENSING

II. SENSORS AND INTERFACING
   A. NONCONTACT SENSORS
      1. VISUAL SENSORS
      2. RANGE SENSORS
   B. CONTACT SENSORS
      1. TOUCH SENSORS
      2. FORCE SENSORS
   C. OTHER ROBOTIC NON-CONTACT AND CONTACT SENSORS
   D. METHOD OF SENSOR INTERFACE TO THE ROBOTS
      1. DIRECT TO THE ROBOT
      2. TO ROBOT VIA PROGRAMMABLE CONTROLLER
      3. CONVERSION OF ANALOG SIGNALS
   E. RESULTS OF SENSOR INTERFACE TO THE ROBOTS
      1. ACCORDING TO PROGRAM ROBOT HALTS, BRANCHES, ETC.
      2. ROBOT OR P.C. PROVIDES EXTERNAL OUTPUT
      3. HOW SENSORS DIFFER

Lesson Plan # 2

Course Title ROBOT SERVICE AND REPAIR Course # _____

Unit Title ROBOT CONTROL SYSTEM Unit # 3

STEP 3 - Classroom, Laboratory, Shop or Other Activities:

STEP 4 - Lesson Summary and Review Items to be Used to Evaluate the Lesson Against the Lesson Objective:

1. WHAT IS MEANT BY THE SENSOR?

   A sensor is some device which converts a physical phenomenon into an electromechanical system inside the robot into the information required for given applications.

2. AN ADAPT ROBOT HAS TWO KINDS OF SENSING. WHAT ARE THEY?

   The two kinds of sensing are:

   A. Internal robotic sensing
   B. External robotic sensing

3. WHAT IS A RANGE SENSOR?

   A range sensor is used to measure the distance from a reference point to a roster of points in the scene.

4. LIST THE METHODS OF SENSOR INTERFACE TO THE ROBOTS.

   Basically, there are 3 methods of sensor interface to the robots:

   A. Direct to robot
   B. Via programmable controller to robot
   C. Conversion of analog signals

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Lesson Plan # 2

Course Title/No. ROBOT SERVICE AND REPAIR Course # _____

Unit Title ROBOT CONTROL SYSTEM Unit # 3

Unit Test Items Oral, Written, or Performance:

TRUE AND FALSE

F 1. MOST OF THE ROBOTS USED IN INDUSTRY TODAY HAVE THE ABILITY TO SEE, FEEL OR RESPOND TO THEIR ENVIRONMENT.

T 2. A ROBOT EQUIPPED WITH SENSORS CAN INCREASE ITS POWER AND FLEXABILITY.

T 3. INTERNAL ROBOTIC SENSING CAN MONITOR THE STATE OF THE ROBOT'S SYSTEM LIKE INTERNAL TEMPERATURE AND JOINT LOADS.

T 4. A TOUCH SENSOR SENSES AND INDICATES A PHYSICAL CONTACT BETWEEN THE OBJECT CARRYING THE SENSOR AND ANOTHER OBJECT.

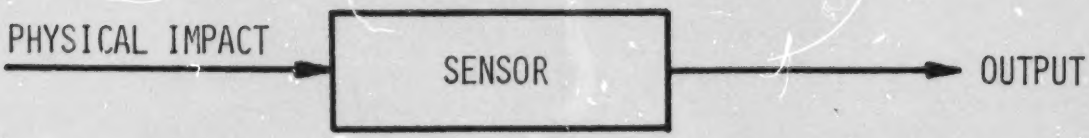
F 5. A FORCE SENSOR MEASURES THE THREE COMPONENTS OF FORCE ACTING BETWEEN TWO OBJECTS, BUT THE TORQUES ARE NOT INCLUDED.

F 6. AN ACOUSTIC SENSOR SENSES ACOUSTIC WAVES ONLY IN GAS AND LIQUID.

COMPLETION

1. SENSORY ABILITY IS THE CAPABILITY OF A ROBOT TO see, feel AND hear THROUGH VARIOUS DEVICES (SENSORS).
2. TRANSDUCING IS A PROCESS OF CONVERTING THE PHYSICAL PROPERTIES INTO AN electrical SIGNAL.
3. THE MAJORITY OF THE RESEARCH SEEMS TO BE AIMED AT monitor PATH CONTROL SYSTEM.
4. TO TRANSLATE THE DATA FROM SENSORS, AND ADAPT THE MONITOR, THE ENVIRONMENT software IS REQUIRED.
5. VISUAL SENSING TRANSDUCERS ARE USUALLY TV cameras.
6. A SIMPLE TOUCH SENSOR IS A micro-switch.
7. AN ACOUSTIC SENSOR SENSES ACOUSTIC WAVES IN gas, liquid OR SOLID.
8. Temperature SENSORS CAN BE BOTH CONTACT AND NONCONTACT SENSORS.

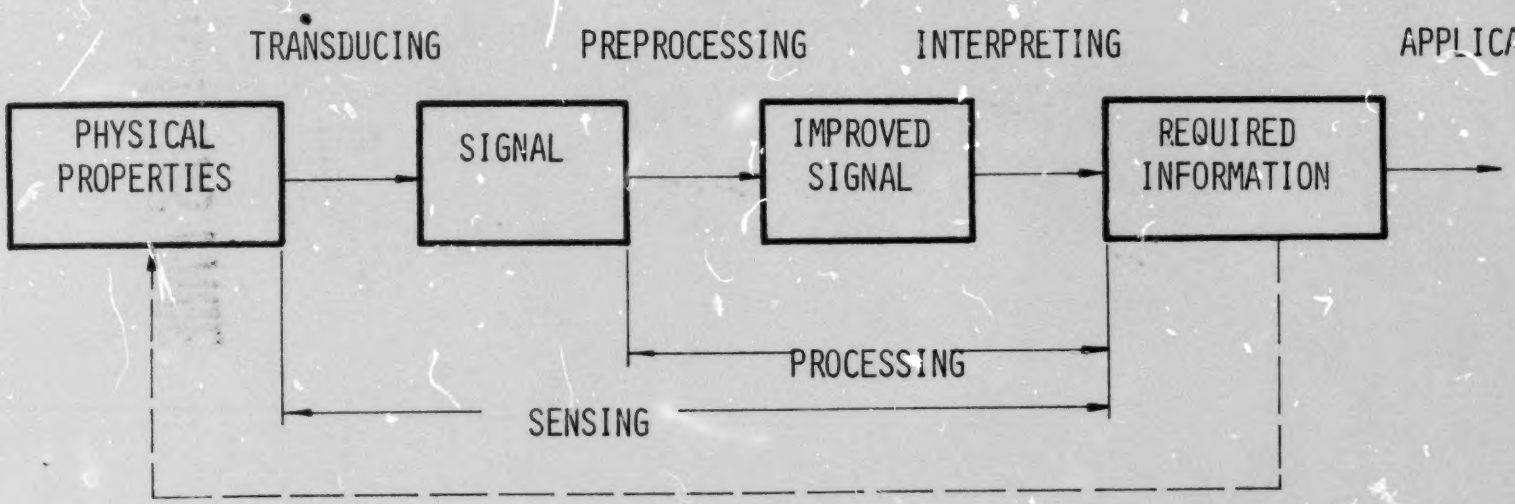
WHAT IS A SENSOR?



MOST SENSORS USED WITH ROBOTS HAVE DISCRETE OUTPUTS.

EXAMPLE: LIMIT SWITCH
LIGHT BEAM

SENSING STEPS



T3-2-3

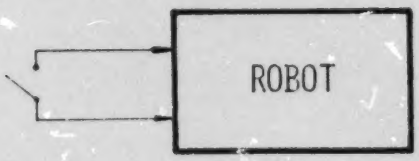
SENSORS: NON-CONTACT

T3-2-4

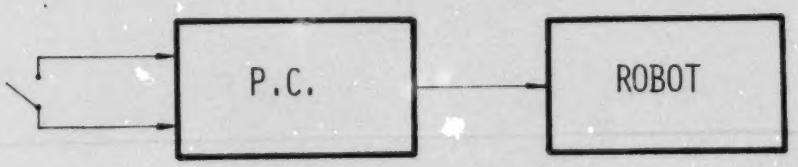
SENSORS: CONTACT

METHODS OF SENSOR INTERFACE TO THE ROBOT

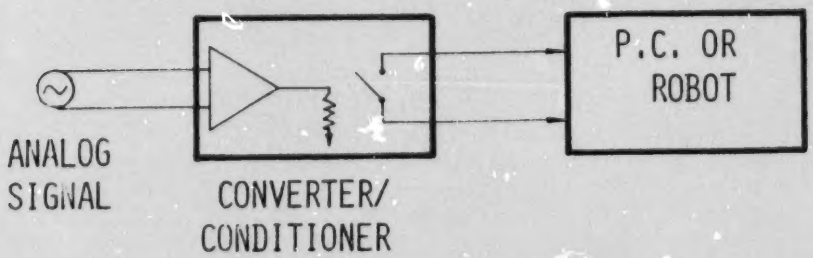
DIRECT TO ROBOT



TO ROBOT VIA PROGRAMMABLE CONTROLLER



CONVERSION OF ANALOG SIGNALS



SENSORS

PROVIDE INPUT TO ROBOT FOR:

--PROCESS CONTROL

--BRANCHING

--SAFETY

HOW SENSORS DIFFER

--WHAT PHYSICAL QUANTITIES THEY MEASURE

--HOW THEY OPERATE

--WHAT ENVIRONMENT THEY OPERATE IN

--WHAT USEFUL RANGES THEY HAVE

--WHAT ACCURACY THEY HAVE

--WHAT REPEATABILITY THEY HAVE

--THEIR EXPECTED LIFE

--THEIR RELIABILITY

--THEIR SIZE

--PRECISION

--SPEED OF RESPONSE

--LINEARITY

--COST

AS3-2-1
KEY

LESSON PLAN #2

UNIT 3--ROBOT CONTROL SYSTEM

ASSIGNMENT SHEET 1

AFTER READING THE INFORMATION SHEETS (IS3-2-1, IS3-2-2, IS3-2-3) PROVIDED, COMPLETE THE FOLLOWING QUESTIONS IN WRITING OR AS REQUESTED BY YOUR INSTRUCTOR.

1. LIST SEVERAL NONCONTACT AND CONTACT SENSORS.

   Contact - Touch sensors, Force sensors
   Noncontact - Visual sensors, Range sensors

2. WHAT ARE THE BEST FORCE SENSORS USED IN ROBOTS?

   The best force transducers for robots are semiconductor strain gauges.

3. LIST SIX ITEMS TO DESCRIBE HOW SENSORS DIFFER?

   A. How they operate.
   B. What accuracy they have.
   C. What repeatability they have.
   D. Their size.
   E. Precision.
   F. Speed of response.
   G. Cost.

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Lesson Plan # 3

Course Title ROBOT SERVICE AND REPAIR Course # _____

Unit Title ROBOT CONTROL SYSTEM Unit # 3

Technical Information Lesson X General /Guidance Information Lesson ____

OR

Job Skill Demonstration Lesson _____

FUNDAMENTALS OF MICROPROCESSOR

LESSON TITLE

Lesson Objective - Upon Completion of This Lesson the Student Should Be Able To:

Tools and Materials:

Teaching Aids:

3-1-H3 SYLLABUS SHEET
T3-3-1 NUMBER SYSTEM
T3-3-2 NUMBER SYSTEM CONVERSION
T3-3-3 BINARY COMPLEMENTS
T3-3-4 BINARY SIGNED NUMBER
T3-3-5 BINARY ARITHMETIC
T3-3-6 LOGIC GATES

Informational Assignment:

INFORMATION SHEETS
IS3-3-1 MICROPROCESSORS
IS3-3-2 LOGIC GATES AND BOOLEAN OPERATION
IS3-3-3 MICROPROCESSOR SYSTEM

ANSWER QUESTIONS FOUND ON ASSIGNMENT SHEETS
AS3-3-1 FUNDAMENTALS OF MICROPROCESSORS

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Individualized Informational Assignment for Special Students:

References:

1. RONY, P.R. INTRODUCTORY EXPERIMENTS IN DIGITAL ELECTRONICS AND 8080A MICROCOMPUTER PROGRAMMING AND INTERFACE. HOWARD W. SAMS AND CO., INC. INDIANAPOLIS, 1982.
2. LENK, J.D. HANDBOOK OF MICROPROCESSORS, MICROCOMPUTERS AND MINICOMPUTERS PRENTICE HALL, INC., NEW JERSEY, 1979.

Step 1 - Introduction for Preparation of the Student:

ALL OF TODAYS MORE SOPHISTICATED ROBOTS USE SOME SORT OF COMPUTER CONTROL. IT IS VERY IMPORTANT TO UNDERSTAND THIS TYPE OF CONTROL. IN THIS UNIT, YOU WILL BE INTRODUCED TO A BASIC MICROPROCESSOR SYSTEM. IN ADDITION, YOU WILL ALSO LEARN THE NUMBER SYSTEM AND THE SIMPLE LOGIC CIRCUIT. SINCE MICROPROCESSORS USE BINARY NUMBERS FOR DATA AND CONTROL, IT IS IMPORTANT THAT YOU BECOME FAMILIAR WITH THEM.

Lesson Plan # 3

Course Title ROBOT SERVICE AND REPAIR Course # _____

Unit Title ROBOT CONTROL SYSTEM Unit # 3

Lesson Title: FUNDAMENTALS OF MICROPROCESSOR

STEP 2 - Presentation Outline:

I. NUMBERING SYSTEM
   - A. DECIMAL SYSTEM
   - B. BINARY NUMBER SYSTEM
   - C. OCTAL NUMBER SYSTEM
   - D. BINARY CODED DECIMAL (BCD) SYSTEM
   - E. HEXADECIMAL NUMBER SYSTEM
   - F. DECIMAL CONVERSION

II. BINARY ARITHMETIC
   - A. BINARY ADDITION
   - B. BINARY SUBTRACTION
   - C. BINARY COMPLEMENTS
   - D. BINARY ARITHMETIC WITH SIGNED NUMBER
   - E. BINARY MULTIPLICATION
   - F. BINARY DIVISION

III. LOGIC GATE AND BOOLEAN OPERATION
   - A. GATE
   - B. TRUTH TABLE
   - C. AND GATE AND ITS OPERATION
   - D. OR GATE AND ITS OPERATION
   - E. NOT GATE AND ITS OPERATION
   - F. NAND GATE AND ITS OPERATION
   - G. NOR GATE AND ITS OPERATION
   - H. EXCLUSIVE OR GATE AND ITS OPERATION

IV. BASIC MICROPROCESSOR SYSTEM
   - A. TERMS
   - B. MICROPROCESSOR SYSTEM
   - C. MICROPROCESSOR UNIT (MPU)
   - D. MEMORY
   - E. I/O UNIT

Lesson Plan # 3

Course Title ROBOT SERVICE AND REPAIR Course # _____

Unit Title ROBOT CONTROL SYSTEM Unit # 3

STEP 3 - Classroom, Laboratory, Shop or Other Activities:

STEP 4 - Lesson Summary and Review Items to be Used to Evaluate the Lesson Against the Lesson Objective:

INTERACTION ITEMS:

1. CONVERT 28_{10} TO A BINARY NUMBER.

```
2 |28 ---0
2 |14 ---0
2 | 7 ---1
2 | 3 ---1
2 | 1 ---1
  | 0
```

$\therefore 28_{10} = 11100_2$

2. CONVERT 11010011_2 TO AN OCTAL NUMBER.

$11010011_2 = 011,010,011_2 = 323_8$

3. CONVERT $8C4_{16}$ TO A BINARY NUMBER.

8 C $4_{16} = 100011000100_2$

↓ ↓ ↓

1000 1100 0100

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4. FIND TWO'S COMPLEMENT OF 01001101.

1) Form a 1's Complement: 01001101 -- 10110010

2) Add 1 at the LSB of the 1's Complement form.

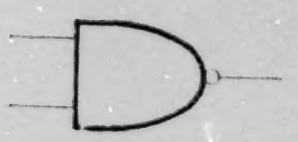
```
  10110010
+        1
----------
  10110011 --- 2's Complement
```

5. THERE ARE THREE BASIC GATES USED IN LOGIC CIRCUITS. THEY ARE (AND), (OR), AND (NOT) GATES.

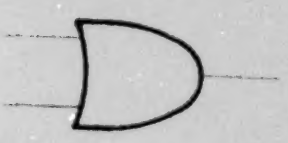
6. WHAT DO THE FOLLOWING SYMBOLS MEAN?

ANSWERS:

EX OR



NAND



OR

AND

7. WHAT DO THE RAM, ROM, EPROM MEAN?

RAM = Random Access Memory
ROM = Read Only Memory
EPROM = Erasable Programmable ROM

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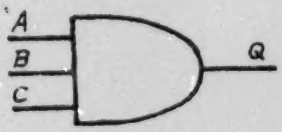
Lesson Plan # 3

Course Title/No. ROBOT SERVICE AND REPAIR Course # _____

Unit Title ROBOT CONTROL SYSTEM Unit # 3

Unit Test Items Oral, Written, or Performance:

1. MATCHING

5	A. INTEGRATED CIRCUIT	1. 27_{10}
8	B. BCD	2. 0 OR 1
1	C. 11011_2	3. 0100101
7	D. 676_8	4. ABC
3	E. 2'S COMPLEMENT OF 1011010	5. IC
2	F. BIT	6. 4 BITS
4	G. 	7. 446_{10}
		8. BINARY CODED DECIMAL
		9. 8 BITS
6	H. NIBBLE	

2. HOW MANY BITS ARE THERE IN THE FOLLOWING NUMBERS?
   A. 11010011_2
   B. 1000000000011001_2
   C. 1001_2

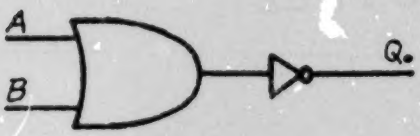
   A. $11010011_2 = 8$
   B. $1000000000011001_2 = 16$
   C. $1001_2 = 4$

3. TO WHAT DECIMAL NUMBER DO THE FOLLOWING BINARY NUMBERS CORRESPOND?
   A. 1101_2
   B. 062_8
   C. 4107_{16}
   D. 10010101_2

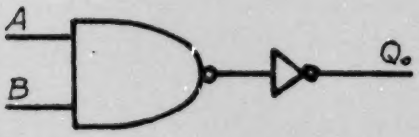
   A. $= (1\times2^4)+(1\times2^3)+(1\times2^2)+(0\times2^1)+(1\times2^0) = 29_{10}$
   B. $= (0\times8^2)+(6\times8^1)+(2\times8^0) = 50_{10}$
   C. $= (4\times16^3)+(1\times16^2)+(0\times16^1)+(7\times16^0) = 16647_{10}$
   D. $= (1\times2^7)+(0\times2^6)+(0\times2^5)+(1\times2^4)+(0\times2^3)+(1\times2^2)+(0\times2^1)+(1\times2^0) = 149_{10}$

4. WRITE A TRUTH TABLE FOR THE FOLLOWING DIAGRAMS. ONCE YOU HAVE DONE THIS, WRITE DOWN THE NAME OF THE GATE THAT CORRESPONDS TO THE TRUTH TABLE.

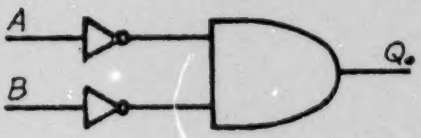
A.



B.



C.



A.

A	B	Q	Q_0
0	0	0	1
0	1	1	0
1	0	1	0
1	1	1	0

→ NOR

B.

A	B	Q	Q_0
0	0	1	0
0	1	1	0
1	0	1	0
1	1	0	1

⟹ AND

C.

A	B	Q_0
1	1	1
1	0	0
0	1	0
0	0	0

5. HOW ARE THE ACCUMULATORS USED?

The accumulators are used to pass data into and out of the MPU, as well as to hold data for further manipulation.

CONVERSION

1. DECIMAL TO BINARY
2. DECIMAL TO OCTAL
3. DECIMAL TO HEXADECIMAL
4. BINARY TO OCTAL
5. BINARY TO BCD
6. BINARY TO HEXADECIMAL

BINARY COMPLEMENTS

1. ONE'S COMPLEMENT
   REVERSE THE DIGITS OF THE NUMBER.

2. TWO'S COMPLEMENT
   A. FORM A ONE'S COMPLEMENT
   B. ADD 1 AT THE LEAST SIGNIFICANT POSITION OF THE ONE'S COMPLEMENT FORM.

BINARY SIGNED NUMBER

IN SIGNED NUMBERS, THE MSB IS THE SIGNED BIT.

0 ----------+ (PLUS)

1 ---------- — (MINUS)

FOR EXAMPLE:

00000101 = +5

11111100 = -3

BINARY ARITHMETIC

1. ADDITION

   0 + 0 = 0
   0 + 1 = 1
   1 + 0 = 1
   1 + 1 = 0 WITH A CARRY OF 1
   1 + 1 + 1 = 1 WITH A CARRY OF 1

2. SUBTRACTION

   0 - 0 = 0
   1 - 1 = 0
   1 - 0 = 1
   0 - 1 = 1 WITH A BORROW OF 1

3. MULTIPLICATION

   0 x 0 = 0
   0 x 1 = 0
   1 x 0 = 0
   1 x 1 = 1

4. DIVISION

   0 ÷ 1 = 0
   1 ÷ 1 = 1

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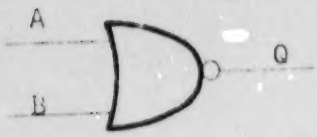
LOGIC GATES

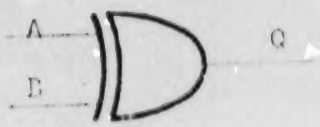
AND

OR

NAND



NOR



EX OR

NOT

LESSON PLAN #3

UNIT 3--ROBOT CONTROL SYSTEM

ASSIGNMENT SHEET 1

AFTER READING THE INFORMATION SHEET (IS3-3-1, IS3-3-2, IS3-3-3) PROVIDED, COMPLETE THE FOLLOWING QUESTIONS IN WRITING OR AS REQUESTED BY YOUR INSTRUCTOR.

1. COMPLETE THE FOLLOWING TABLE.

BINARY	DECIMAL	OCTAL	HEXADECIMAL
10110110	91_{10}	266_8	$B6_{16}$
111111_2	63	77_8	$3F_{16}$
011011_2	27_{10}	33	$1B_{16}$
10111110_2	190_{10}	276_8	BE

2. CALCULATE THE FOLLOWING MULTIPLICATION.

$$\begin{array}{r} 10.01_2 \\ \times\ 1.01_2 \\ \hline \end{array}$$

$$\begin{array}{r} 10.01_2 \\ \times\ 1.01_2 \\ \hline 10\ 01 \\ 000\ 0 \\ 1001 \\ \hline 10.1101 \end{array}$$

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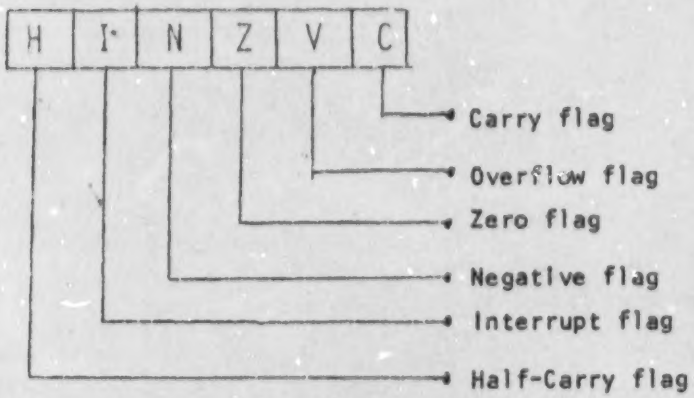
3. THERE ARE THREE BASIC SECTIONS IN ALL DIGITAL COMPUTERS. WHAT ARE THEY?

A. CPU or MPU
B. Memory = RAM, ROM etc.
C. I/O devices

4. WHAT IS MEANT BY THE FOLLOWING CONDITION CODES?



5. WHAT IS THE DIFFERENCE BETWEEN VOLATILE AND NONVOLATILE MEMORY?

Volatile - Store information that is lost when the power to the memory is switched off.

Non-Volatile - Stores information that is retained when the power is removed, i.e., permanent memory.

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Lesson Plan # 1

Course Title ROBOT SERVICE AND REPAIR Course # _____

Unit Title SERVICE AND REPAIR Unit # 4

Technical Information Lesson X General /Guidance Information Lesson ____

OR

Job Skill Demonstration Lesson X

ELECTRONIC METERS AND THEIR TECHNIQUES

LESSON TITLE

Lesson Objective - Upon Completion of This Lesson the Student Should Be Able To:

1. VERBALLY DEFINE THE TERMS ASSOCIATED WITH VOLTAGE AND MEASURE THE VOLTAGE DROPS IN A DC CIRCUIT.
2. VERBALLY DEFINE THE TERMS ASSOCIATED WITH CURRENT AND MEASURE THE CURRENT WITH AN AMMETER AND CONVERT AMPERES TO MILLIAMPS AND MICOAMPS.
3. VERBALLY DEFINE THE TERMS ASSOCIATED WITH RESISTANCE AND SHOW THE ABILITY TO MEASURE CIRCUIT RESISTANCE WITH AN OHMMETER.

Tools and Materials:

1. MULTIMETER
2. VOLTMETER
3. THREE DIFFERENT BATTERIES
4. LAMP
5. SWITCH
6. DC AMMETER
7. DC POWER SOURCE

Teaching Aids:

H4-1-1 SYLLABUS SHEET
T4-1-1 VOLTAGE
T4-1-2 VOLTAGE SYMBOLS AND DEFINITIONS
T4-1-3 DC VOLTMETER APPLICATION
T4-1-4 VOLTMETER SCALE AND RANGE SWITCH
T4-1-5 KIRCHHOFF'S LAW OF VOLTAGE
T4-1-6 CURRENT

*TEACHING AIDS CONTINUED ON REVERSE SIDE.

CENTER

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Teaching Aids: CONTINUED

T4-1-7 CURRENT SYMBOLS
T4-1-8 PREFIXES
T4-1-9 SERIES AND PARALLEL CIRCUIT
T4-1-10 AMMETER APPLICATION
T4-1-11 TYPICAL AMMETER
T4-1-12 RESISTANCE
T4-1-13 SYMBOL USED FOR RESISTANCE AND RESISTORS
T4-1-14 OHMMETER

Informational Assignment:

INFORMATION SHEETS
IS4-1-1 VOLTAGE AND ITS MEASURING TECHNIQUE
IS4-1-2 CURRENT AND ITS MEASURING TECHNIQUE
IS4-1-3 VOLTAGE

ANSWER QUESTIONS FOUND ON ASSIGNMENT SHEETS
AS4-1-1 EXPERIMENT

References:

1. MILES, RITTER-SANDERS, ELECTRONIC METERS: TECHNIQUES AND TROUBLE-SHOOTING, RESTON PUBLISHING COMPANY, INC., VIRGINIA, 1977.

Step 1 - Introduction for Preparation of the Student:

IN THE FIELD OF ELECTRICITY AND ELECTRONICS, AS IN ALL OF THE OTHER PHYSICAL SCIENCES, ACCURATE QUANTITATIVE MEASUREMENTS ARE ESSENTIAL THESE INVOLVE TWO IMPORTANT ITEMS - NUMBERS AND UNITS.

A TECHNICIAN COMMONLY WORKS WITH AMMETERS, VOLTMETERS, OHMMETERS IN MAINTAINING AND TROUBLESHOOTING ELECTRICAL AND ELECTRONIC EQUIPMENT. TO THE TECHNICIAN; A GOOD UNDERSTANDING OF THE FUNCTIONAL DESIGN AND OPERATION OF ELECTRICAL INSTRUMENTS IS IMPORTANT.

IN ELECTRICAL OR ELECTRONIC SERVICING PROCEDURES, ONE OR MORE OF THE FOLLOWING METHODS ARE COMMONLY USED TO DETERMINE IF THE CIRCUITS IN A UNIT OF EQUIPMENT ARE FUNCTIONING NORMALLY.

A. USE A VOLTMETER TO DETERMINE THE VOLTAGE EXISTING BETWEEN TWO POINTS IN A CIRCUIT.
B. USE AN AMMETER TO MEASURE THE AMOUNT OF CURRENT FLOWING IN A CIRCUIT.
C. USE AN OHMMETER TO CHECK FOR CIRCUIT CONTINUITY AND TO MEASURE TOTAL AND PARTIAL CIRCUIT RESISTANCE.

IN THIS LESSON PLAN, THE STUDENT WILL UNDERSTAND AND KNOW HOW TO USE ELECTRONIC METERS TO DO MAINTENANCE AND TROUBLESHOOTING WORKS.

Lesson Plan # 1

Course Title ROBOT SERVICE AND REPAIR Course # _____

Unit Title SERVICE AND REPAIR Unit # 4

Lesson Title: ELECTRONIC METERS AND THEIR TECHNIQUE

STEP 2 - Presentation Outline:

I. VOLTAGE AND ITS MEASURING TECHNIQUES
   A. TERMINOLOGY (T4-1-1)
   B. VOLTAGE SYMBOLS AND DEFINITION (T4-1-2)
   C. BASIC PARTS OF A VOLTMETER
   D. PROCEDURES FOR USING A VOLTMETER (T4-1-3, T4-1-4)
   E. KIRCHHOFF'S LAW OF VOLTAGE (T4-1-5)

II. CURRENT AND ITS MEASURING TECHNIQUES
   A. TERMINOLOGY (T4-1-6)
   B. CURRENT SYMBOLS (T4-1-7, T4-1-8)
   C. PROCEDURE FOR MEASURING CURRENT WITH A DC AMMETER (T4-1-9, T4-1-10, T4-1-11)

III. RESISTANCE
   A. TERMINOLOGY (T4-1-12)
   B. PREFERRED RESISTANCE VALUES
   C. SYMBOLS USED FOR RESISTANCE AND RESISTORS (T4-1-13)
   D. PARTS OF AN OHMMETER (T4-1-14)
   E. RESISTANCE MEASURING PROCEDURE

Lesson Plan # 1

Course Title ROBOT SERVICE AND REPAIR Course # _____

Unit Title SERVICE AND REPAIR Unit # 4

STEP 3 - Classroom, Laboratory, Shop or Other Activities:

EXPERIMENT 1: MEASURE AND COMPARE THE VOLTAGE OF THREE DIFFERENT BATTERIES.

EXPERIMENT 2: MEASURE THE VOLTAGE DROP IN A DC CIRCUIT.

EXPERIMENT 3: MEASURE AND COMPARE CURRENT AT TWO POINTS OF A CIRCUIT.

EXPERIMENT 4: MEASURE AND COMPARE CURRENT IN A CIRCUIT AT TWO DIFFERENT VOLTAGE LEVELS.

EXPERIMENT 5: MEASURE CIRCUIT RESISTANCE WITH AN OHMMETER.

STEP 4 - Lesson Summary and Review Items to be Used to Evaluate the Lesson Against the Lesson Objective:

INTERACTIVE ITEMS:

1. DEFINITION:
   A. VOLTAGE:

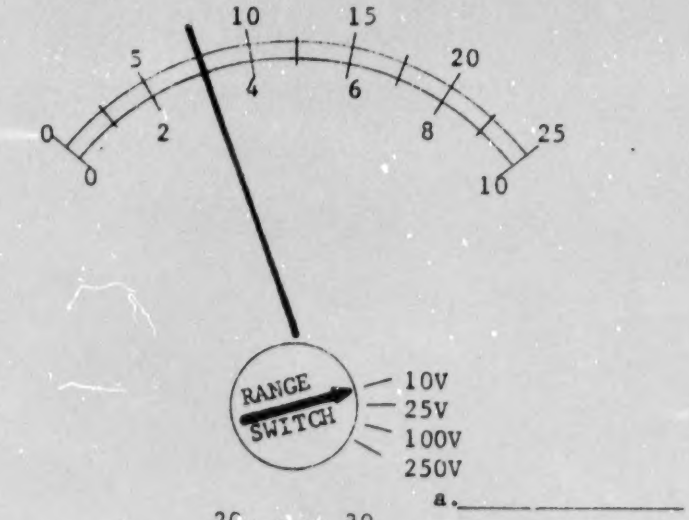
   B. CURRENT FLOW:

   C. AMPERE:

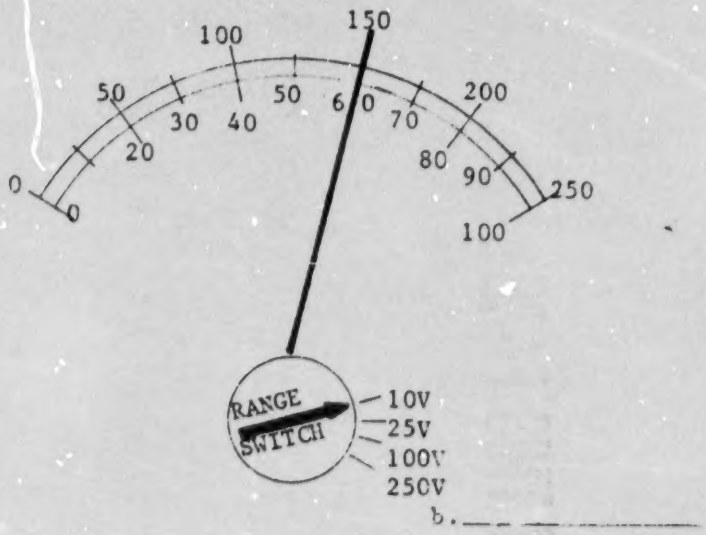
   D. RESISTANCE:

2. SYMBOL AND ABBREVIATION.
   KV=
   MV=
   PA=
   Ⓐ =
   Ⓥ =

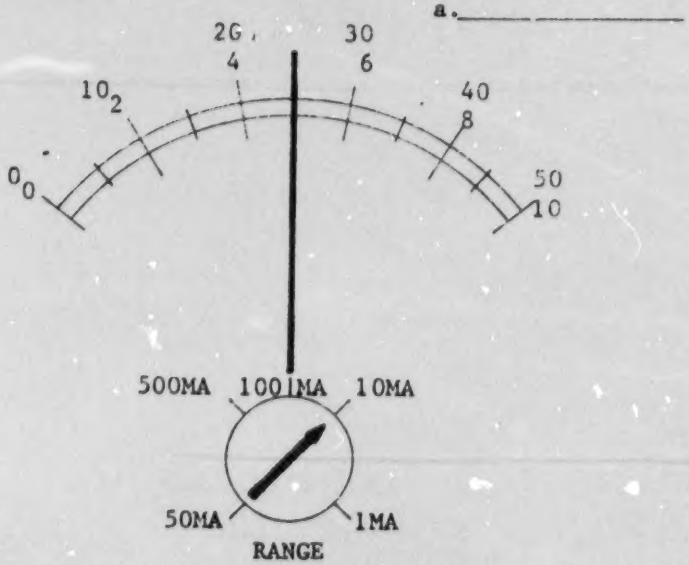
3. WRITE DOWN THE READINGS INDICATED BY THE SCALES.



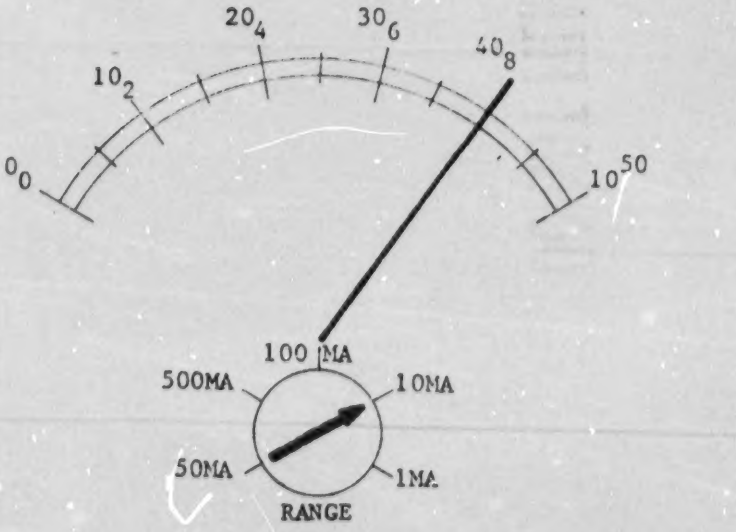
a. _____



b. _____



c. _____



d. _____

4. CONVERT THE FOLLOWING ITEMS:

A. 2 AMPS=_____MILLIAMPS

B. 0.0550A=_____MA

C. 4 AMPS=_____MA

D. 2.45 MA=_____A

E. .35=_____MA

F. 2,360,000MA=_____A

Lesson Plan # 1

Course Title ROBOT SERVICE AND REPAIR Course # _____

Unit Title SERVICE AND REPAIR Unit # 4

STEP 3 - Classroom, Laboratory, Shop or Other Activities:

EXPERIMENT 1: MEASURE AND COMPARE THE VOLTAGE OF THREE DIFFERENT BATTERIES.

EXPERIMENT 2: MEASURE THE VOLTAGE DROP IN A DC CIRCUIT.

EXPERIMENT 3: MEASURE AND COMPARE CURRENT AT TWO POINTS OF A CIRCUIT.

EXPERIMENT 4: MEASURE AND COMPARE CURRENT IN A CIRCUIT AT TWO DIFFERENT VOLTAGE LEVELS.

EXPERIMENT 5: MEASURE CIRCUIT RESISTANCE WITH AN OHMMETER.

STEP 4 - Lesson Summary and Review Items to be Used to Evaluate the Lesson Against the Lesson Objective:

INTERACTIVE ITEMS:

1. DEFINITION:
   - A. VOLTAGE: Voltage is pressure or electromotive force that makes electrons "want to move."
   - B. CURRENT FLOW: The rate of electron flow through a conductor.
   - C. AMPERE: A flow of 6.28×10^{18} electrons per second is called an ampere.
   - D. RESISTANCE: Resistance is the internal friction involved in the passing of electons through a wire.
2. SYMBOL AND ABBREVIATION.
   - KV= Kilovolts
   - MV= Microvolts
   - PA= Picoamperes
   - Ⓐ = Ammeter
   - Ⓥ = Voltmeter

4. CONVERT THE FOLLOWING ITEMS:

A. 2 AMPS= 2.000 MILLIAMPS

B. 0.0550A= .55 MA

C. 4 AMPS= 4,000,000 MA

D. 2.45 MA= 0.00245 A

E. .35= 3.50 MA

F. 2,360,000MA= 2.36 A

Lesson Plan # 1

Course Title/No. ROBOT SERVICE AND REPAIR Course # _____

Unit Title SERVICE AND REPAIR Unit # 4

Unit Test Items **Oral, Written, or Performance:**

1. MATCH THE TERMS OR SYMBOLS ON THE RIGHT WITH THE CORRECT DEFINITIONS.

8	A. A RESISTOR WITH A RESISTANCE VALUE THAT CAN BE CHANGED.	1. E
7	B. ONE THOUSAND OHMS.	2. MV
6	C. AN INSTRUMENT USED FOR MEASURING RESISTANCE.	3. VOLTAGE
2	D. MICROVOLT.	4. PARALLEL CIRCUIT
3	E. A PRESSURE THAT CAUSES THE FLOW OF ELECTRICAL CURRENT.	5. RESISTANCE
4	F. A CIRCUIT WITH MULTIPLE PATHS FOR CURRENT FLOW.	6. OHMMETER
1	G. VOLTAGE OR VOLTAGE DROP.	7. KILOHM
5	H. OPPOSITION WHICH A DEVICE OR MATERIAL OFFERS TO THE FLOW OF ELECTRICAL CURRENT.	8. ADJUSTABLE RESISTOR

2. NAME THREE COMMON SOURCES OF VOLTAGE.
   - A. Batteries
   - B. Generators/alternators
   - C. Electronic power supplies

3. WHAT ARE THE PRINCIPAL PARTS OF A TYPICAL VOLTMETER?
   - A. Connecting leads or probes
   - B. Voltage, current; resistance function switch
   - C. Direct current, alternating current function switch
   - D. Multiple use scales
   - E. Range switch

4. STATE THE FORMULAS FOR VOLTAGE DROPS IN RESISTIVE CIRCUITS.

A. Voltage in circuit equal power source. $V_1+V_2 = E$

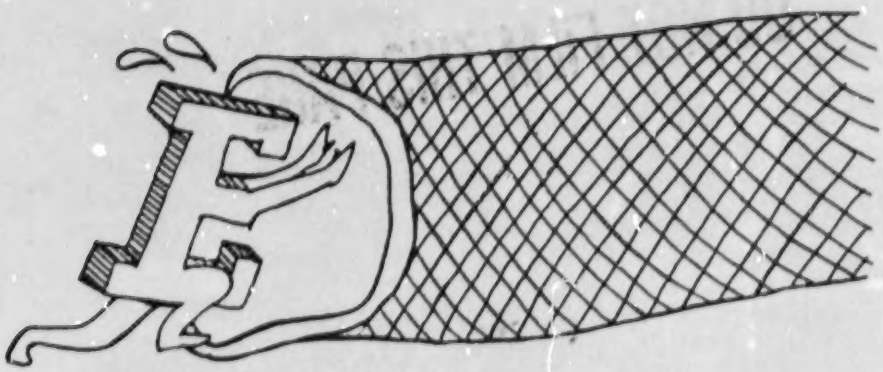
B. Algebraic sum of voltage drops equal zero. $V_1+V_2-E = 0$

5. WHAT ARE THE REASONS FOR PREFERRED VALUES USED?

A. Helps limit the numbers of parts that need to be manufactured and stocked.

B. Helps insure availability of interchangeable resistors.

VOLTAGE



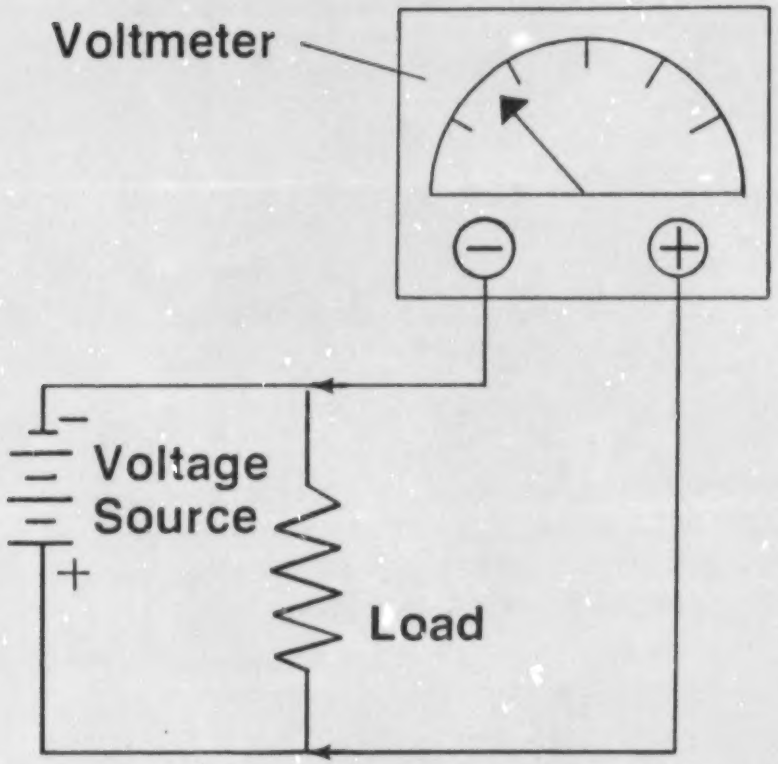
VOLTAGE IS PRESSURE, OR ELECTROMOTIVE FORCE.
VOLTAGE MAKES ELECTRONS "WANT TO MOVE."

SYMBOL: E OR V
MEASURED IN: VOLTS (V)
INSTRUMENT: VOLTMETER (Ⓥ)

VOLTAGE SYMBOLS AND DEFINITIONS

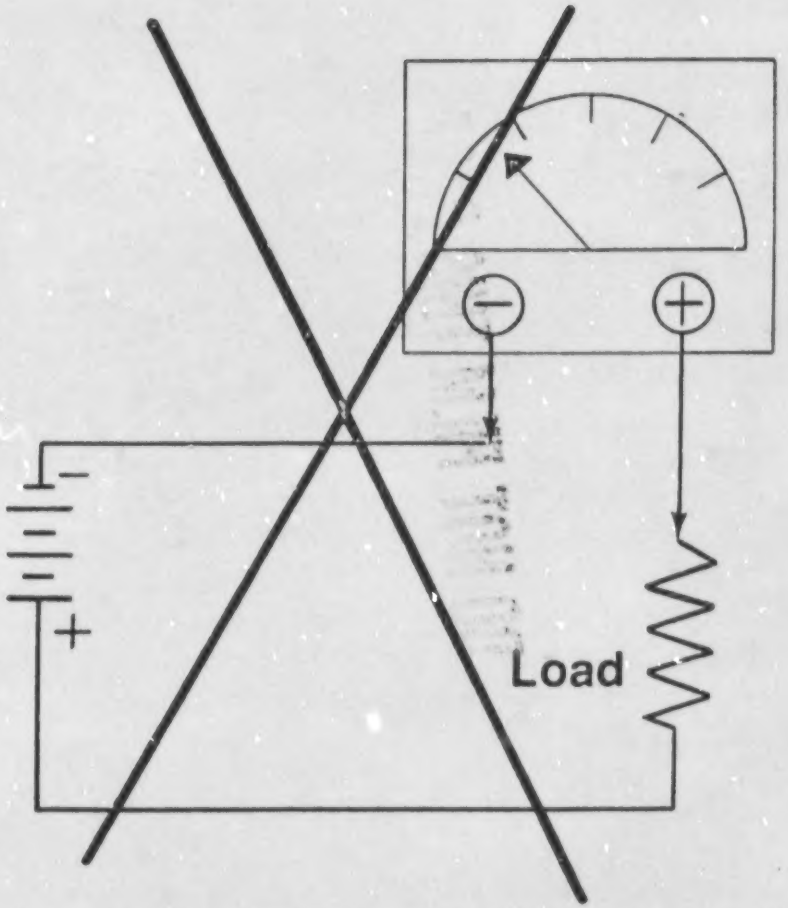
SYMBOLS	DEFINITIONS
EMF	ELECTROMOTIVE FORCE
E	VOLTAGE SOURCE OR APPLIED VOLTAGE
V	VOLTAGE OR VOLTAGE DROP KV--KILOVOLT (10^3V) MV--MEGAVOLT (10^6V) mV--MILLIVOLT (10^{-3}V) uV--MICROVOLT (10^{-6}V)
VM	VOLTMETER

DC VOLTMETER APPLICATION



Voltmeter should be in parallel with load

243

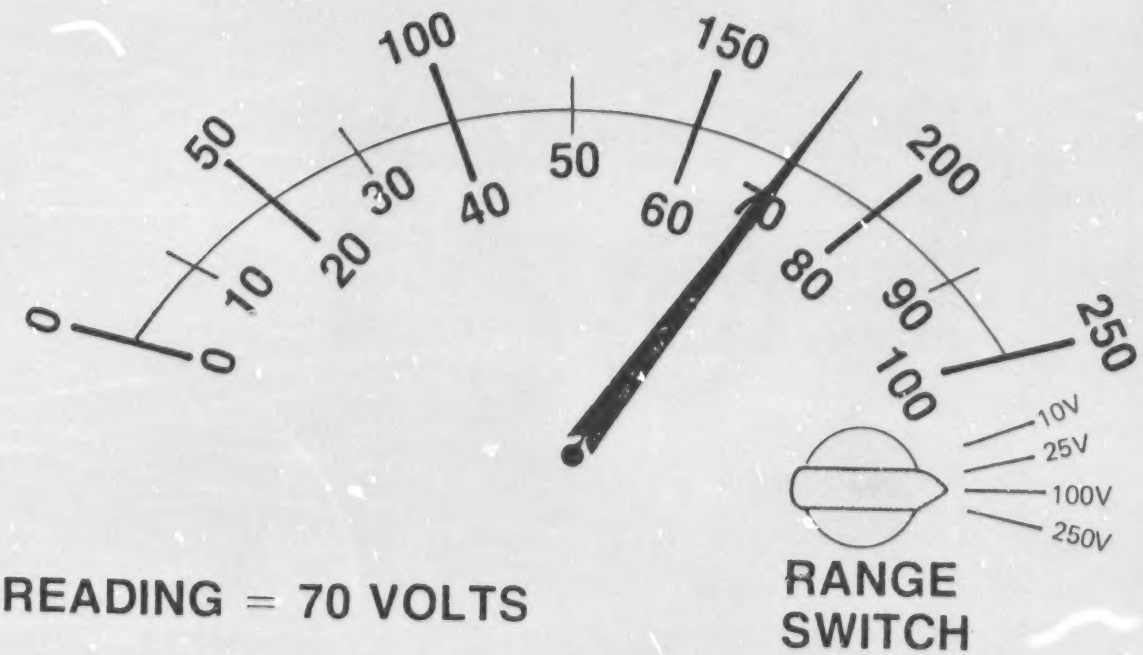


NEVER in Series

244

T4-1-5

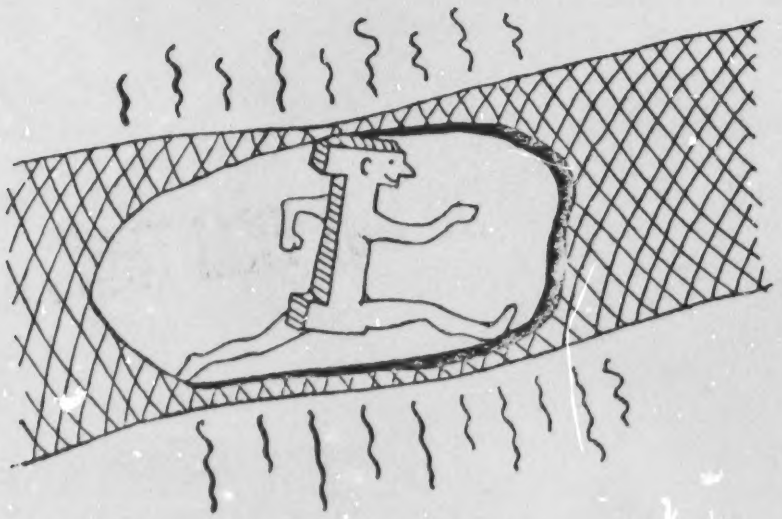
0
0
5
2
10
4
15
6
20
8
25
10
= 7.5V
10V
25V
RANGE
SWITCH


0
0
10
50
20
30
100
40
50
150
60
70
200
80
90
100
250
READING = 70 VOLTS
10V
25V
100V
250V
RANGE
SWITCH

KIRCHOFF'S LAW OF VOLTAGE

THE ALGEBRAIC SUM OF THE VOLTAGES AROUND A CLOSED LOOP MUST EQUAL THE APPLIED VOLTAGE.

Current

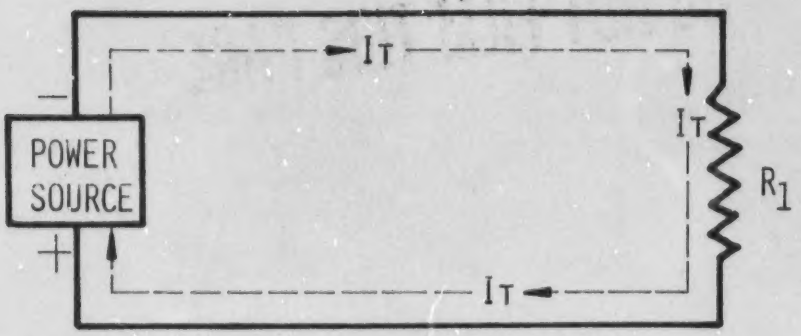


CURRENT: CURRENT IS THE RATE OF FLOW OF ELECTRONS
CURRENT FLOW: THE RATE OF ELECTRON FLOW THROUGH A CONDUCTOR.
AMPERE: A FLOW OF 6.28×10^{18} ELECTRONS PER SECOND IS CALLED AN AMPERE.
INSTRUMENT USED TO MEASURE:
AMMETER
SYMBOL-- Ⓐ OR Ⓐ

UNIT: AMPERE
SYMBOL--"I"

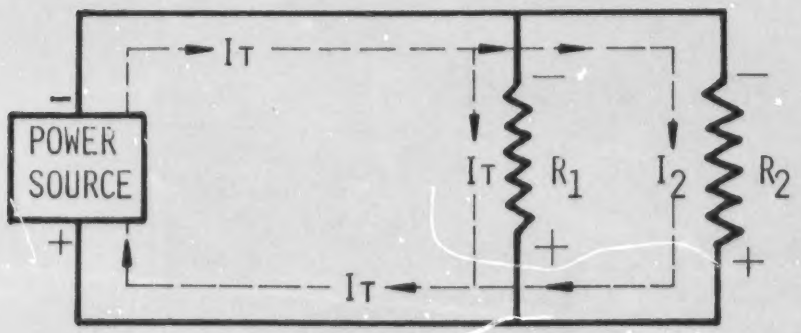
CURRENT SYMBOLS	
SYMBOLS	EXPLANATION
I	CURRENT
A OR AMP	AMPERE
Q OR Q	COULOMB
A OR A	AMMETER
MA	MILLIAMPERE (10^{-3} AMP)
MA	MICROAMPERE (10^{-6} AMP)
PA	PICOAMPERE (10^{-12} AMP)

PREFIXES		
MILLI = .001 = 1/1000		= 1×10^{-3}
MICRO = .000001 = 1/1000000		= 1×10^{-6}
PICO = .000000000001 = 1/1,000,000,000,000		= 1×10^{-12}
KILO = 1000		= 1×10^{3}
MEGA = 1,000,000		= 1×10^{6}



SERIES CIRCUIT

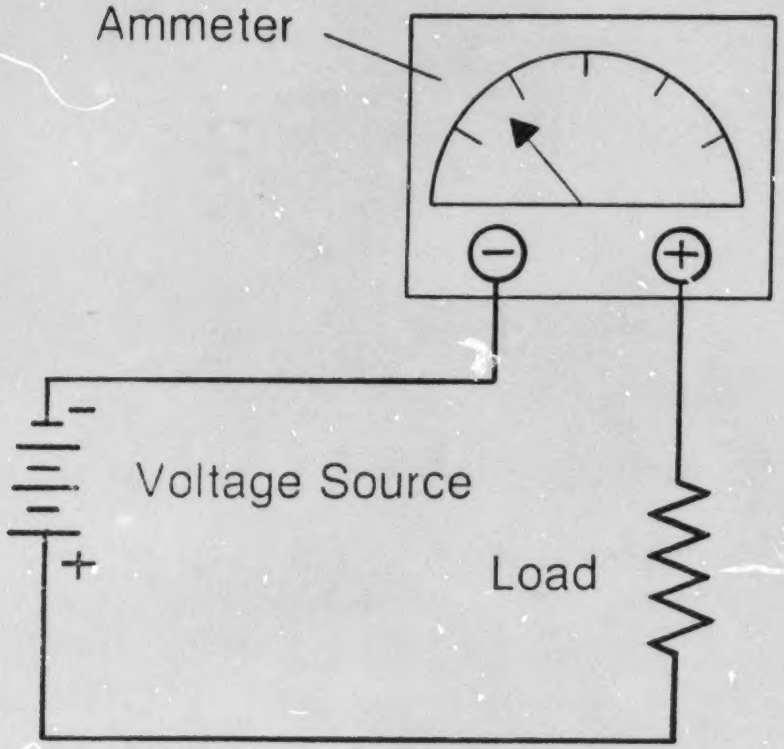
I_T = TOTAL CURRENT
I_1 = PARTIAL CURRENT THROUGH R_1
I_2 = PARTIAL CURRENT THROUGH R_2



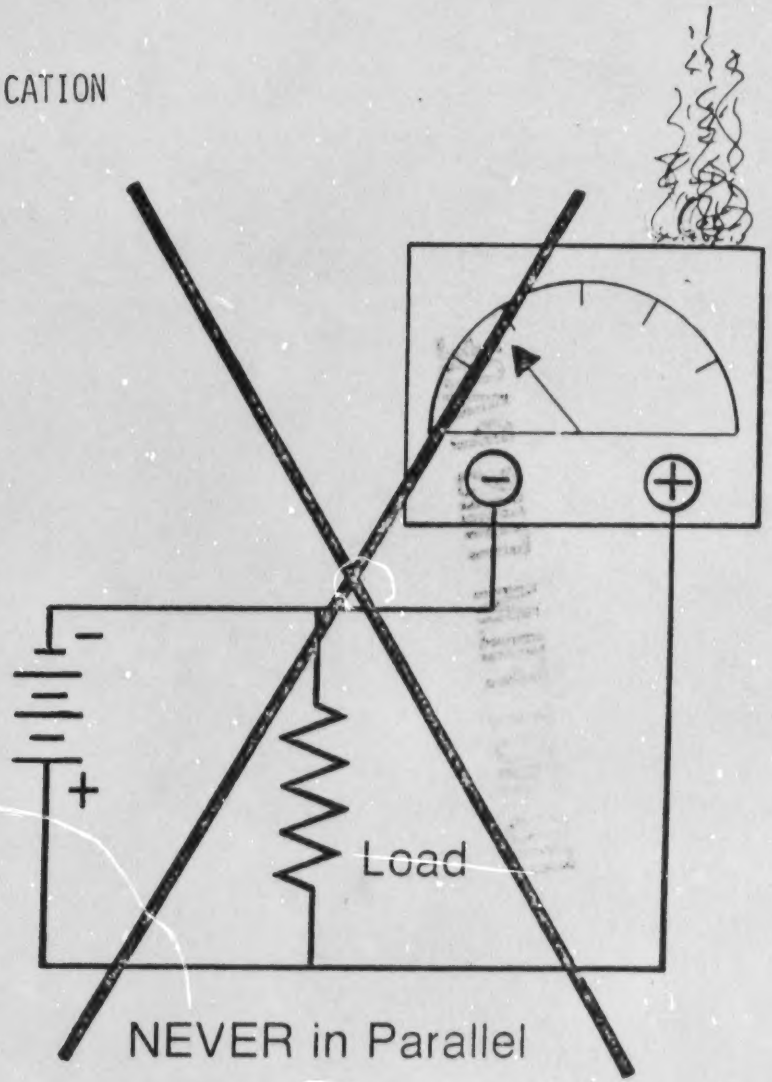
PARALLEL CIRCUIT

SERIES AND PARALLEL CIRCUITS

AMMETER APPLICATION



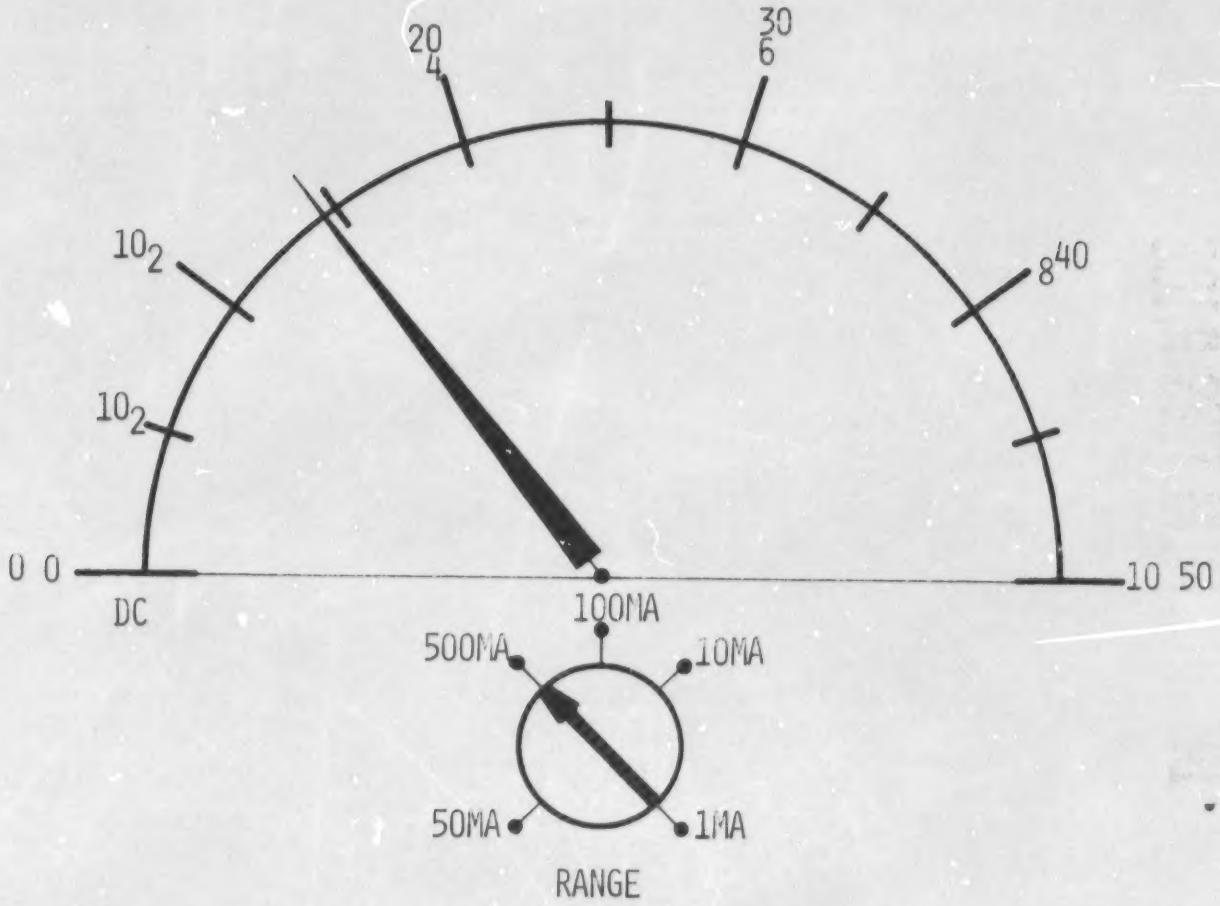
Ammeter should be in series with load



NEVER in Parallel

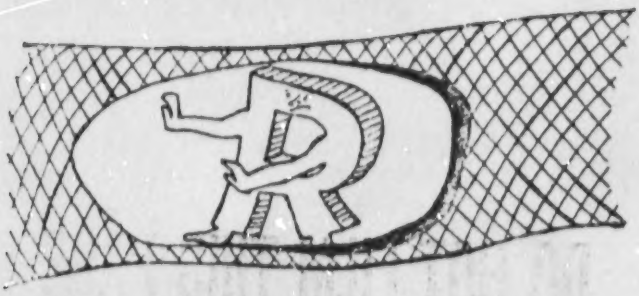
T4-1-10

DC CURRENT SCALE AND RANGE SWITCH ON TYPICAL AMMETER.



T4-1-11

RESISTANCE



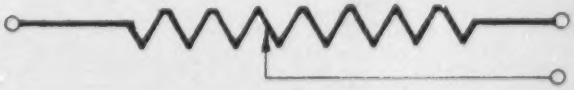
RESISTANCE IS OPPOSITION TO CURRENT FLOW.

A. DEFINITION: RESISTANCE CAN BE SAID TO BE THE INTERNAL FRICTION INVOLVED IN THE PASSING OF ELECTRONS THROUGH A WIRE.

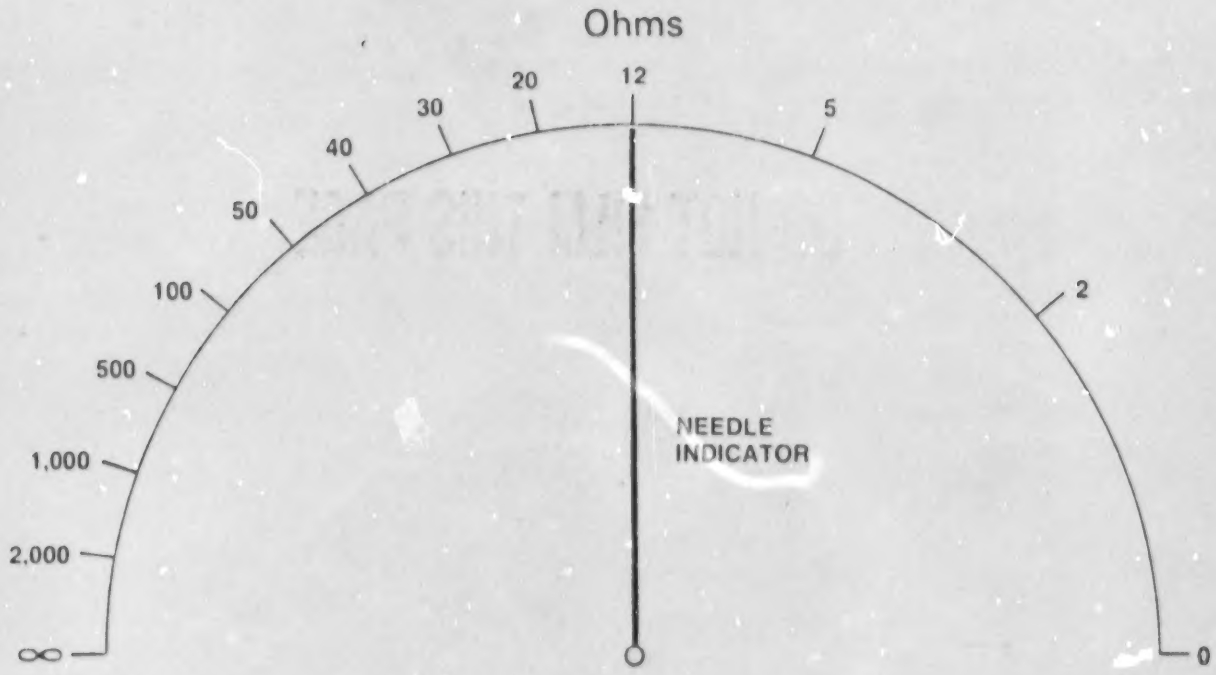
B. SYMBOL: R

C. MEASURED IN: OHMS

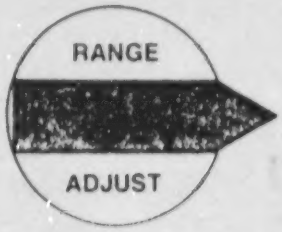
D. INSTRUMENT: OHMMETER

ITEM	LETTER SYMBOL	SCHEMATIC SYMBOL
OHM	OMEGA Ω	
KILO HM	K ORKK Ω	
MEGOHM	M OR M Ω	
RESISTOR	R	
FIRST, SECOND, THIRD, ETC. RESISTOR	R, R_2 R_3 ETC.	
VARIABLE (TAPPED WIRE) RESISTOR	R	
POTENTIOMETER	R	
RHEOSTAT	R	

SYMBOL USED FOR RESISTANCE AND RESISTORS



* THE ∞ SYMBOL MEANS "INFINITY" OR INFINITE RESISTANCE



R X 1

R x 1000

R x 10,000

WITH RANGE ADJUST SET ON	METER INDICATION IS
R x 1	12 x 1 or 12 Ohms
R x 100	12 x 1,000 or 12,000 Ohms
R x 10,000	12 x 10,000 or 120,000 Ohms

OHMMETER SCALE AND RANGE SETTING

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LESSON PLAN #1

UNIT 4--ELECTRONIC METERS AND THEIR TECHNIQUES

ASSIGNMENT SHEET 1

AFTER READING THE INFORMATION SHEETS (IS4-1-1 THROUGH IS4-1-3) PROVIDED, COMPLETE THE FOLLOWING QUESTIONS IN WRITING OR AS REQUESTED BY YOUR INSTRUCTOR.

1. Voltage drop IS THE DIFFERENCE IN VOLTAGE MEASURED ACROSS A COMPONENT IN A CIRCUIT.
2. INSTRUMENT USED TO MEASURE VOLTAGE IS CALLED A voltmeter.
3. MV = megavolt (10^6V).
4. MULTIMETER AND ELECTRONIC METERS HAVE SEVERAL SCALES FOR INDICATION OF ELECTRICAL QUANTITIES SUCH AS DC voltage, AC voltage, resistance, DC current, AND DECIBEL VALUES.
5. A CIRCUIT WITH MULTIPLE PATHS FOR CURRENT FLOW IS CALLED parallel circuit.
6. Ampere IS THE UNIT OF MEASUREMENT OF ELECTRICAL CURRENTS.
7. pA = Picoampere = 10^{-12} amp.
8. Resistance IS AN OPPOSITION WHICH A DEVICE OR MATERIAL OFFERS TO THE FLOW OF ELECTRIC CURRENTS.
9. Fixed resistor IS A RESISTOR WITH A RESISTANCE VALUE THAT CANNOT BE VARIED.
10. RANGE SELECTOR SWITCH:
    R x 1 = multiply indication by 1
    R x 1000 = multiply indication by 1000
11. KIRCHHOFF'S LAW OF VOLTAGE IS:
    The algebraic sum of the voltage which drops around a closed loop, must equal the applied voltage.

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Lesson Plan # 2

Course Title ROBOT SERVICE AND REPAIR Course # _____

Unit Title SERVICE AND REPAIR Unit # 4

Technical Information Lesson X General /Guidance Information Lesson _____

OR

Job Skill Demonstration Lesson X

MAINTENANCE AND SERVICE

LESSON TITLE

Lesson Objective - Upon Completion of This Lesson the Student Should Be Able To:

1. VERBALLY DESCRIBE THE ROBOT MAINTENANCE CONDITIONS AND EXPLAIN HOW TO DO IT.
2. VERBALLY DESCRIBE THE GENERAL TROUBLESHOOTING PRINCIPLES AND THEIR PROCEDURES IN DIFFERENT SITUATIONS.

Tools and Materials:

1. STANDARD HAND TOOLS
2. MICROMETER
3. DEPTH GAUGE
4. OHMMETER
5. VOLTMETER
6. ALIGNMENT TOOL

Teaching Aids:

H4-2-1 SYLLABUS SHEET
T4-2-1 ROBOT ARM
T4-2-2 ROBOT ARM (JOINT)
T4-2-3 CONTROL SYSTEM, BLOCK DIAGRAM

Informational Assignment:

IS4-2-1 MAINTENANCE
IS4-2-2 TROUBLESHOOTING AND SERVICE
ANSWER QUESTIONS FOUND ON ASSIGNMENT SHEET
AS4-2-1 MAINTENANCE AND SERVICE

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Pittsburg State University

PSU

Individualized Informational Assignment for Special Students:

References:

1. ENGELBERGER, JOSEPH F., ROBOTICS IN PRACTICE: MANAGEMENT AND APPLICATIONS OF INDUSTRIAL ROBOTS, AMERICAN MANAGEMENT ASSOCIATION, NEW YORK, 1980.

Step 1 - Introduction for Preparation of the Student:

IT IS SAID MAINTENANCE IS MORE IMPORTANT THAN REPAIR. THERE ARE TWO SECTIONS THAT WILL BE COVERED IN THIS PLAN: MAINTENANCE AND TROUBLESHOOTING AND SERVICE. IN THIS LESSON PLAN, THE STUDENT WILL LEARN AND UNDERSTAND HOW TO MAINTAIN AN INDUSTRIAL ROBOT, AND IF THE ROBOT DOES SOMETHING WRONG, THEY WILL BE ABLE TO FIND OUT AND REPAIR IT.

Lesson Plan # 2

Course Title ROBOT SERVICE AND REPAIR Course # _____

Unit Title SERVICE AND REPAIR Unit # 4

Lesson Title: MAINTENANCE AND SERVICE

STEP 2 - Presentation Outline:

I. MAINTENANCE
   A. GENERAL CONSIDERATION (T4-2-1, T4-2-2)
   B. GEAR LUBRICATION
      1. WAIST JOINT
      2. SHOULDER JOINT
      3. ELBOW JOINT
   C. BEARING WEAR OR INADEQUATE PRELOAD
      1. GENERAL
      2. WAIST JOINT
      3. SHOULDER JOINT
      4. ELBOW JOINT
      5. WRIST JOINT
   D. BACKLASH ADJUSTMENT
      1. GENERAL
      2. WAIST JOINT
      3. SHOULDER JOINT
      4. ELBOW JOINT
      5. WRIST JOINT
   E. ELECTRICAL HARNESS WEAR INSPECTION

II. TROUBLESHOOTING AND SERVICE (T4-2-3)

A. TOOLS AND SPECIAL EQUIPMENT

B. GENERAL PRINCIPLE FOR TROUBLESHOOTING

C. CONCEPT OF INTERCHANGEABILITY

D. PUMA ROBOT CONTROL SYSTEM AND BLOCK DIAGRAM

E. PRE-TROUBLESHOOTING GUIDE

1. ENSURE ALL BOARDS ARE IN THEIR PROPER SLOT
2. MAKE SURE BOARDS ARE ALL SEATED SQUARELY IN THE BACK-PLANE
3. MAKE SURE ALL CABLES ARE PROPERLY CONNECTED

F. TROUBLESHOOTING PROCEDURE

1. POWER ON ERROR
2. INITIALIZATION ERRORS
3. POST INITIALIZATION ERRORS
4. HIGH POWER TURN-ON ERROR
5. TEACH PENDANT FUNCTIONAL ERROR
6. CALIBRATION PROBLEMS
7. OPERATING ERRORS

G. SERVICE

1. WRIST REPLACEMENT
2. OUTER LINK REPLACEMENT
3. INNER LINK REPLACEMENT
4. INNER LINK MOTOR REPLACEMENT

Lesson Plan # 2

Course Title ROBOT SERVICE AND REPAIR Course # _____

Unit Title SERVICE AND REPAIR Unit # 4

STEP 3 - Classroom, Laboratory, Shop or Other Activities:

STEP 4 - Lesson Summary and Review Items to be Used to Evaluate the Lesson Against the Lesson Objective:

1. WHICH TWO PARTS OF A ROBOT ARE REGULARLY REQUIRED FOR MAINTENANCE?
   1. arm
   2. controller

2. THE BEARINGS IN THE PUMA ROBOT ARM ARE DESIGNED FOR long time.

3. IN BACKLASH ADJUSTMENT, WITH WHICH PARTS ARE WE USUALLY DEALING?
   a. waist joint
   b. shoulder joint
   c. elbow joint
   d. wrist joint

4. WHAT KINDS OF TOOLS AND EQUIPMENT ARE USED FOR TROUBLESHOOTING AND SERVICE?
   a. standard hand tools
   b. micrometer
   c. depth gauge
   d. ohmmeter
   e. voltmeter
   f. alignment tools

5. BEFORE WE DO TROUBLESHOOTING, WHAT DO WE NEED TO ENSURE FIRST?

a. Ensure all boards are in their proper slot.
b. Make sure boards are all seated squarely in the backplane.
c. Make sure all cables are properly connected.

6. WHEN _____ OR _____ IS POWER TURNED ON, DO NOT REPLACE COMPONENTS OR MAKE ADJUSTMENTS TO A ROBOT.

Lesson Plan # 2

Course Title/No. ROBOT SERVICE AND REPAIR Course # _____

Unit Title SERVICE AND REPAIR Unit # 4

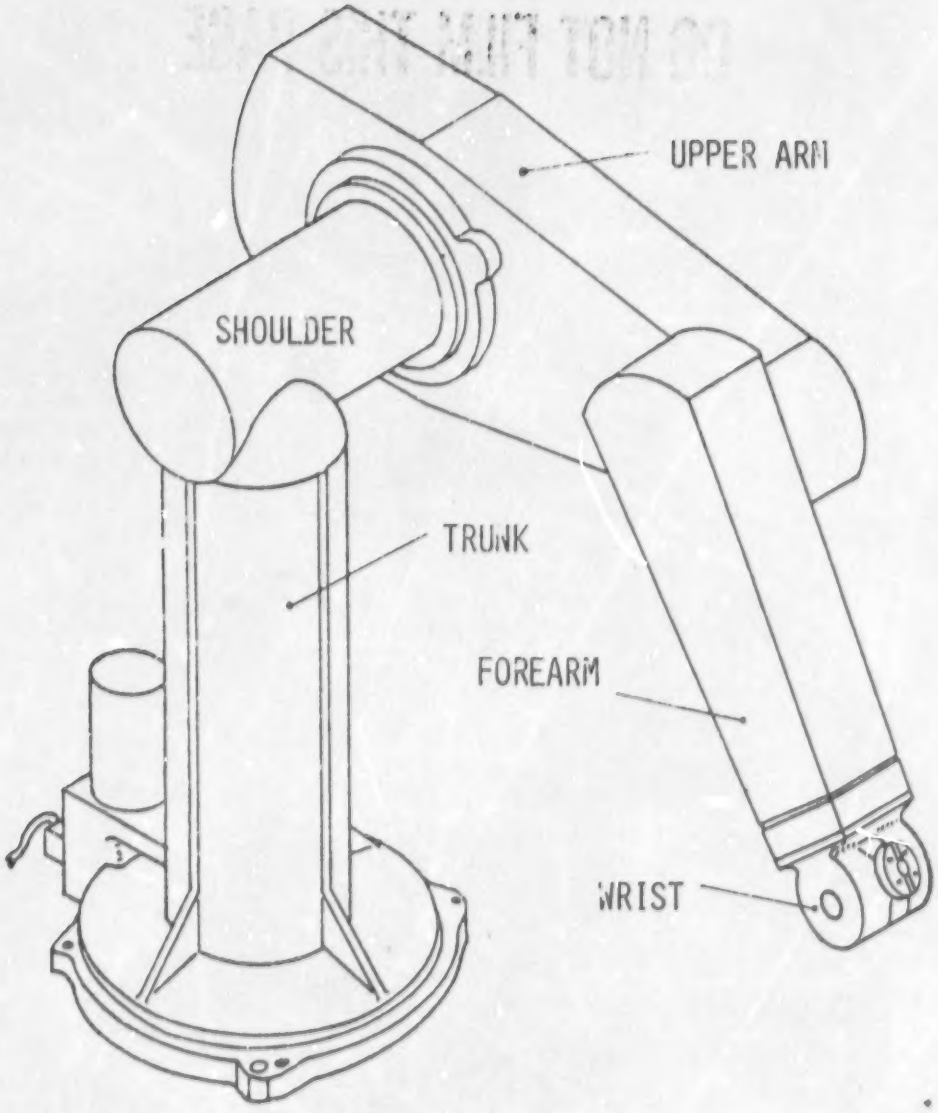
Unit Test Items Oral, Written, or Performance:

TRUE-FALSE

T 1. LUBRICATE GEARS EVERY 1000 HOURS OF OPERATING TIME.
T 2. CLEAN OR REPLACE AIR FILTERS IN ACCORDANCE WITH ENVIRONMENTAL CONDITIONS. CLEAN WITH CLEAR WATER OR APPROPRIATE CLEANING SOLVENT.
F 3. IF NO FAN MOTION OF A ROBOT AFTER THE SWITCH IS TURNED ON, IT MEANS SOME LIGHTS ARE BURNT OUT.
T 4. IF THE ROBOT JOINT IS OUT OF RANGE, ONE POSSIBLE SITUATION IS THAT THE ARM CABLE CARD IS NOT SEATED PROPERLY IN BACKPLANE.
F 5. IN ORDER TO SAVE TIME, WHEN YOU REPLACE COMPONENTS OR MAKE ADJUSTMENTS TO A ROBOT, YOU DON'T NEED TO TURN THE POWER OFF.
T 6. AFTER YOU GET A PART REPLACED, THE PERFORMANCE OF BACKLASH CHECKS AND ADJUSTMENTS ARE NECESSARY.

COMPLETION

1. THE PUMA ROBOT ARM IS THE MECHANICAL COMPONENT OF THE SYSTEM INCORPORATING 6 DEGREES OF FREEDOM. EACH OF THESE IS CONTROLLED BY A DC SERVOMOTOR .
2. THE BEARING IN THE ROBOT ARM IS DESIGNED FOR LONG LIFE . THEY SHOULD BE CHECKED EVERY 2000 HOURS OF OPERATING TIME OR SOONER.
3. BACKLASH ADJUSTMENTS MAY BE MADE WITHOUT REMOVING ANY COVERS. ONLY ACCESS HOLE PLUGS MUST BE REMOVED.
4. SINCE THE PHYSICAL BLOCKS ARE MODULAR AND INTERCHANGEABLE . PROBLEMS MAY BE FOUND AND SOLVED BY REPLACING THE FAULTY PHYSICAL BLOCKS.
5. IF ARM OF A ROBOT DOES NOT RESPOND, THE POSSIBLE CORRECTIVE ACTION COULD BE TURN ARM POWER ON AGAIN AND REPLACE FAULTY BLOCK.
6. IN ORDER TO KEEP A ROBOT IN PROPER OPERATING CONDITION, IT IS REQUIRED THAT THE USER HAVE AN AVAILABLE SPARE PARTS KIT .



ROBOT ARM
(MEMBER IDENTIFICATION)

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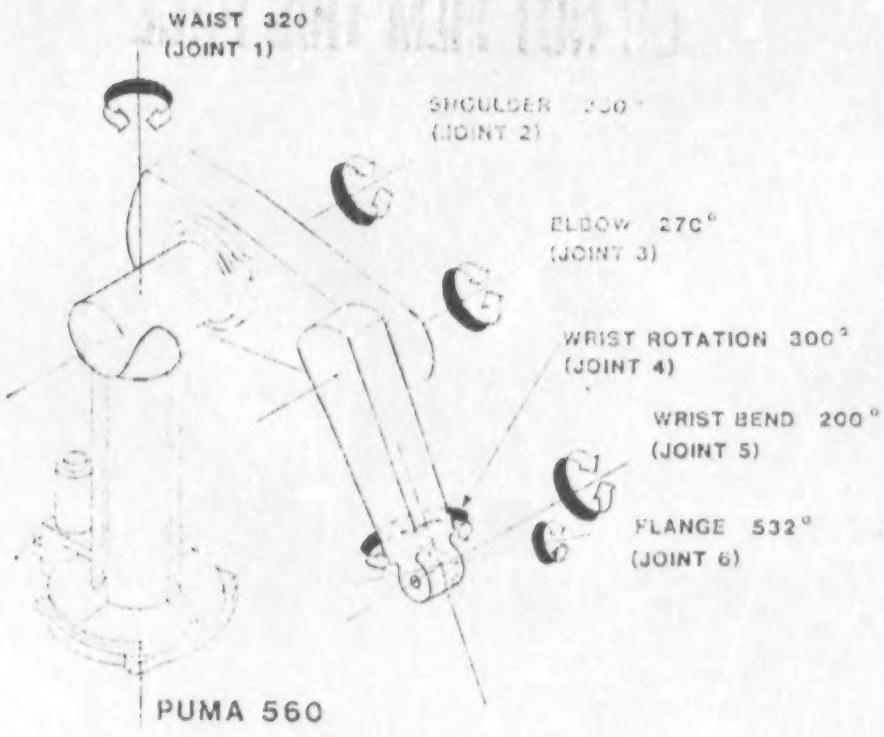

ROBOT ARM
(DEGREE OF JOINT ROTATION)

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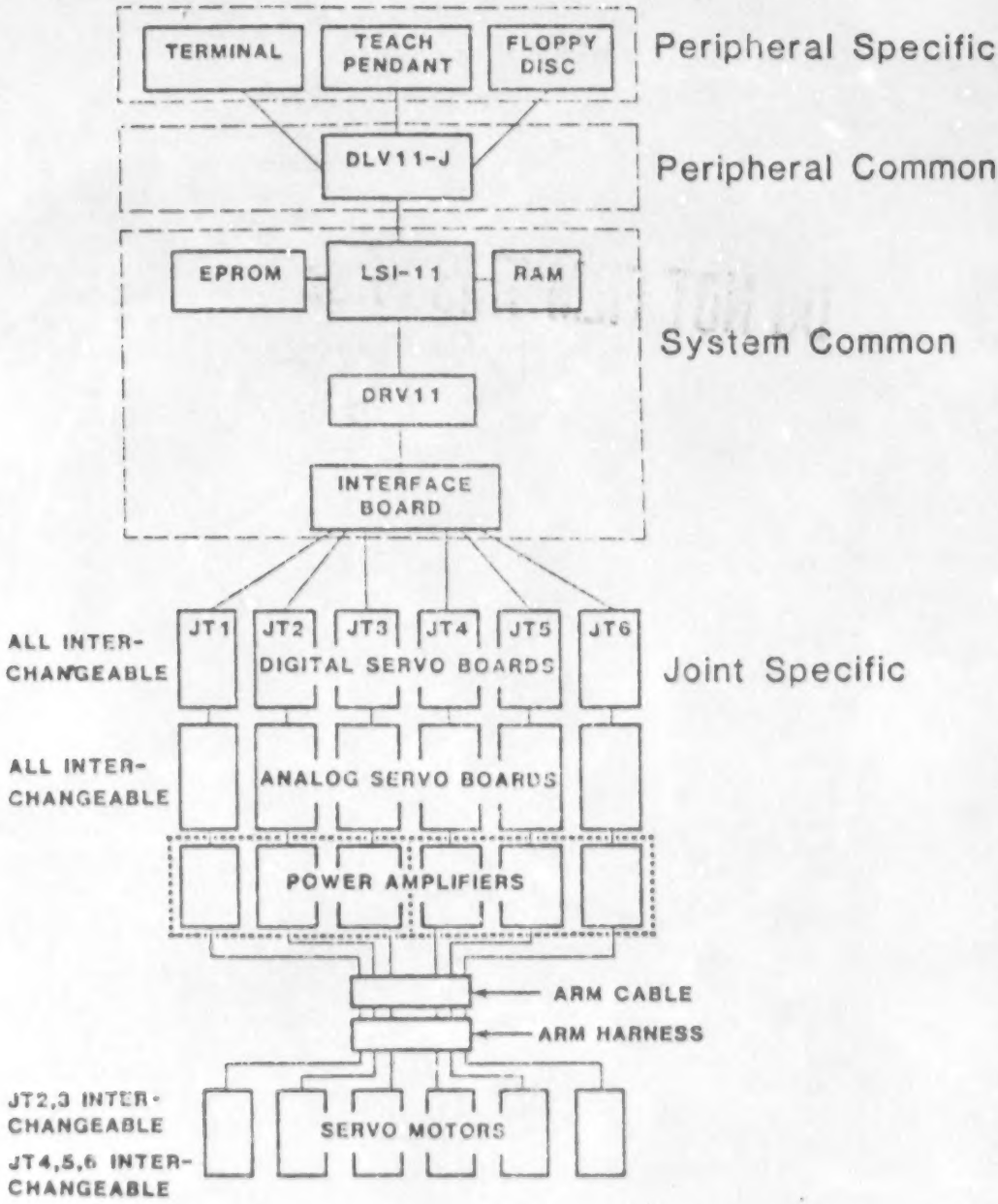

CONTROL SYSTEM, BLOCK DIAGRAM.
(PUMA ROBOT)

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LESSON PLAN #2

UNIT 4--MAINTENANCE AND SERVICE

ASSIGNMENT SHEET 1

AFTER READING THE INFORMATION SHEETS (IS4-2-1, IS4-2-2) PROVIDED, COMPLETE THE FOLLOWING QUESTIONS IN WRITING OR AS REQUESTED BY YOUR INSTRUCTOR.

1. HOW DO YOU GET THE GEAR LUBRICATION IN THE SHOULDER JOINT OF THE PUMA ROBOT?
   A. Remove side panel.
   B. Locate the gear reduction housing at shoulder end of upper arm.
   C. Apply grease through grease fitting.
   D. Replace the side panel.

2. IF THE POWER SWITCH IS TURNED ON, AND THERE ARE NO LIGHTS ON THE FRONT PANEL, WHAT SHOULD YOU DO?
   To do this troubleshooting, the corrective action must take place:
   A. Check plug and fuse.
   B. Check the light to see if it is burnt out.
   C. Check AC power at terminal block.
   D. Check AC at fan connector with voltmeter.

3. WHAT ARE THE POSSIBLE CAUSES IF POST INITIALIZATION HAPPENS?
   A. ADC dead, or servo dead.
   B. Joints out of range.
   C. PROM error-Check it or replace it.
   D. Memory error-Check it or replace it.
   E. No messages-Attempt restarting it by turning power off and on again.

4. DESCRIBE THE PROCEDURES OF REPLACING A INNER LINK MOTOR ON THE PUMA ROBOT.

A. Remove inner link access cover.

B. Unplug joint 2 motor connector.

C. Remove joint 2 motor screws and remove motor.

D. Install parts in reverse order of removal.

5. WHAT POSSIBLE CAUSES COULD HAPPEN IF THE TEACH PENDANT FUNCTIONS IMPROPERLY?

A. Faulty teach pendant.

B. Failure to move in free mode.

C. No response in joint mode.

D. Joint moves out of control in joint mode.

E. Gripper control not in operation.

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Lesson Plan # 3

Course Title ROBOT SERVICE AND REPAIR Course # _____

Unit Title SERVICE AND REPAIR Unit # 4

Technical Information Lesson X General /Guidance Information Lesson X

OR

Job Skill Demonstration Lesson _____

SAFETY

LESSON TITLE

Lesson Objective - Upon Completion of This Lesson the Student Should Be Able To:

1. VERBALLY DESCRIBE THE SAFETY IN ROBOT APPLICATION.
2. VERBALLY EXPLAIN THE FUNCTION OF ROBOT SENSORS.
3. VERBALLY DESCRIBE THE ROBOT MAINTENANCE SAFETY.

Tools and Materials:

Teaching Aids:

1. H4-3-1 SYLLABUS
2. T4-3-1 SAFETY
3. T4-3-2 SENSOR SAFETY
4. T4-3-3 ROBOT MAINTENANCE SAFETY

Informational Assignment:

1. IS4-3-1 PERSONNEL SAFETY
2. IS4-3-2 ROROT SAFETY
3. IS4-3-3 MAINTENANCE SAFETY

ANSWER THE QUESTIONS FOUND ON INFORMATION SHEETS

1. AS4-3-1 SAFETY

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Room 116 Willard Hall
Phone (316) 231-7000 ext. 317
Pittsburg State University

Individualized Informational Assignment for Special Students:

References:

1. ZIANKOSKI, S. & HSI A., PERSONNEL SAFETY & ROBOT SAFETY, STATE UNIVERSITY OF NEW YORK COLLEGE OF TECHNOLOGY, 1982.
2. SAFFORD, EDWARD L., THE COMPLETE HANDBOOK OF ROBOTICS, THE TAB BOOK COMPANY, 1976.

Step 1 - Introduction for Preparation of the Student:

A SAFE AND GOOD WORKING ENVIRONMENT HAVE BEEN IDENTIFIED AS ESSENTIAL COMPONENTS IN ALL ACCIDENT PREVENTION PROGRAMS.

IN THIS LESSON PLAN, THE STUDENT WILL LEARN AND UNDERSTAND THE REGULATIONS OF PERSONNEL SAFETY AND ROBOT SAFETY USED ON ROBOT WORKING AREA.

Lesson Plan # 3

Course Title ROBOT SERVICE AND REPAIR Course # _____

Unit Title SERVICE AND REPAIR Unit # 4

Lesson Title: SAFETY

STEP 2 - Presentation Outline:

I. PERSONAL SAFETY (T4-3-1)

II. ROBOT SAFETY (T4-3-2)
- A. EXTERNAL SENSORS USED FOR SAFETY
  1. PRESSURE SENSITIVE MATS
  2. LIGHT CURTAINS
  3. LIGHT BEAM BASICS
  4. ARM MOUNTED BILL SWITCHES
  5. MULTIPLE ACTUATORS
- B. INTERNAL SENSORS
  1. SENSORS TO MONITOR INTERNAL HAZARD CONDITIONS
  2. HARDWARE OR SOFTWARE CAN MONITOR THE SIGNALS FROM SUCH SENSOR DEVICES

III. MAINTENANCE SAFETY (T4-3-3)

Lesson Plan # 3

Course Title ROBOT SERVICE AND REPAIR Course # _____

Unit Title SERVICE AND REPAIR Unit # 4

STEP 3 - Classroom, Laboratory, Shop or Other Activities:

STEP 4 - Lesson Summary and Review Items to be Used to Evaluate the Lesson Against the Lesson Objective:

1. WHAT WILL WE USUALLY DO WHEN WE ARE PRESSING ARM POWER ON BUTTON OF A ROBOT?

   We usually keep the other hand near arm power off button for emergency shutdown if necessary and keep all other personnel away from the robot's arm maximum reach.

2. LIST FOUR ITEMS THAT KEEP THE OPERATOR AWAY FROM DANGER OF RECEIVING ELECTRICAL SHOCKS OR TRIPPING OVER LOOSE CABLES.

   a. Covers protecting high voltage circuits must not be removed.
   b. Loose cables, hoses and wires must be adequately supported.
   c. The robot body must be efficiently grounded.
   d. Electric tools like spot welding guns must have their cases connected to the ground.

3. WHAT DO WE USUALLY USE TO PROTECT THE ROBOT FROM COLLISIONS WITH OBJECTS AND PERSONS WHO WANDER IN THE ROBOT OPERATION AREA?

Sensors.

4. WHAT CONDITIONS ARE TO BE MONITORED BY USING THE INTERNAL SENSORS?

a. Pneumatic pressure,
b. Hydraulic pressure,
c. Loss of line voltage,
d. Excessive temperature, speed, force and,
e. Flow restrictions.

5. Plastics ARE USED TO PROTECT THE ROBOT FROM CORROSIVE MATERIALS WHICH COULD CAUSE DETERIORATION.

Lesson Plan # 3

Course Title/No. ROBOT SERVICE AND REPAIR Course # _____

Unit Title SERVICE AND REPAIR Unit # 4

Unit Test Items Oral, Written, or Performance:

TRUE-FALSE

T 1. AREA OF ARM REACHED MUST BE DISTINCTLY MARKED.
F 2. WHEN THE ARM OF A ROBOT IS MOVING OR HOLDING A WEIGHTED OBJECT, WE CAN STOP IT IF NECESSARY.
F 3. COVERS PROTECTING HIGH VOLTAGE CIRCUITS COULD BE REMOVED.
T 4. HARDWARE OR SOFTWARE CAN MONITOR THE SIGNALS FROM THE SENSOR DEVICES.
T 5. ROBOT SERVOS AND WIRING SHOULD BE KEPT INTERNAL TO PROTECT FROM HOSTILE ENVIRONMENT.

COMPLETION

1. BEFORE PRESSING ARM POWER ON BUTTON OF A ROBOT, THE OPERATOR AND ALL OTHER PERSONNEL AND OBSTRUCTIONS MUST BE clear OF THE ROBOT'S ARM MAXIMUM REACH.
2. Guard rails AND safety chains CAN PREVENT PERSONNEL FROM ACCIDENTALLY WALKING INTO THE ROBOT OPERATION AREA.
3. THE robot body MUST BE EFFICIENTLY GROUNDED.
4. THE SENSORS USED FOR ROBOT SAFETY HAVE TWO CATEGORIES: internal sensors AND external sensors.
5. Plastics ARE USED TO PROTECT THE ROBOT FROM CORROSIVE MATERIALS WHICH COULD CAUSE DETERIORATION.

SAFETY

PERSONNEL SAFETY

ROBOT SAFETY

-EXTERNAL SENSOR
-INTERNAL SENSOR

MAINTENANCE SAFETY

ROBOT MAINTENANCE SAFETY

-ALL POWER MUST BE SHUT DOWN.
-ALL HYDRAULIC AND AIR POWER SHOULD BE REMOVED.
-ARM MUST BE SUPPORTED TO PREVENT COLLAPSE.

LESSON PLAN #3

UNIT 4--SAFETY

ASSIGNMENT SHEET 1

AFTER READING THE INFORMATION SHEET IS4-3-1 PROVIDED, COMPLETE THE FOLLOWING QUESTIONS IN WRITING AS REQUESTED BY YOUR INSTRUCTOR

1. WHAT IS THE LIGHT CURTAINS USED FOR IN A ROBOT SAFETY ENVIRONMENT?

   The light curtain is used as a sensor to shut the robot off when someone comes within reach.

2. WHERE ARE THE LIGHT BEAM BARRIERS PUT ON AND WHY ARE THEY USED AS EXTERNAL SENSORS FOR THE ROBOTS?

   A. Placed around normal working volume of the robot. If the arm breaks the beam, then the arm is shut down.

   B. Placed around the robot operation area. If personnel step into the robot's working volume, the beam is broken and the robot is shut down.

3. WHAT SAFETY PRECAUTIONS SHOULD BE TAKEN WHEN MAINTAINING A ROBOT?

   A. All power must be shut down.
   B. All hydraulic and air power should be removed.
   C. Arm must be supported to prevent collapse.

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4. TURN OFF ALL CONTROLLER POWER AND UNPLUG CONTROLLER FROM LINE POWER BEFORE REMOVING OR INSTALLING A fuse .

5. START ROBOT ARM MOTION AT slow SPEED, WHEN ARM PATHS ARE FULLY DEFINED AND TESTED, SPEED MAY BE increased .